2009

Colby College State of Maine's Environment 2009

Colby College

State of Maine's Environment 2009

Colby Environmental Policy Group

Colby College
Environmental Studies Program
Waterville, Maine

State of Maine's Environment 2009

Colby Environmental Policy Group

John Abbett
Emily Boone
Samuel Brakeley
Megan Browning
Chris Englert
Steve Erario
Zachary Ezor
Meghan Grogan

The *State of Maine's Environment* is a series of reports written and produced by the Colby Environmental Policy Group, senior environmental policy majors at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report created by students enrolled in *ES 493: Environmental Policy Practicum* taught by Philip J. Nyhus, Assistant Professor of Environmental Studies at Colby College.

Suggested Citation for Full Report: Colby Environmental Policy Group. 2009. *State of Maine's Environment 2009*. Waterville, Maine: Colby College Environmental Studies Program.

Contact: Philip J. Nyhus, Assistant Professor of Environmental Studies, Colby College, Waterville, ME 04901 <pjnyhus@colby.edu>

Electronic Version of Report: https://wiki.colby.edu/display/stateofmaine2009/

Contents

Executive Summary

State of Maine's Environment 2009

The *State of Maine's Environment* is a regular series of reports written by senior environmental policy majors at Colby College in Waterville, Maine. *The State of Maine's Environment 2009* is the fifth State of Maine's Environment report created by students enrolled in ES 493: Environmental Policy Practicum taught by Philip J. Nyhus, Environmental Studies Program. Topics in this report include four topics of importance to Maine: Coastal Marine Policy, Rivers and Dams, Organic Farms, and Sustainable Cities. In each chapter, we explore the history and context of the topic, evaluate its current state, and conclude with major findings and policy recommendations.

In *The State of Coastal and Marine Policy*, we find that Maine's coastal and marine (ocean) resources play a vital role in the health of Maine's economy. In 2007, Maine's coastal municipalities employed 55% of the state's population and accounted for 60% of the state's gross domestic product (GDP). The vitality and character of these municipalities are at risk if the state's coastal and marine economic resources are degraded. Presently, threatened resources such as Maine's sea urchin and sea scallop fisheries are managed by the state and federal governments in a series of issue and species-specific management plans. The spatial boundaries of these plans geographically overlap, creating a network of interconnecting regions, management strategies, and authorities. In our assessment, we found that 68% of the geographical area in Maine's state waters is characterized by having 10 or more overlapping management zones and regulatory bodies.

Further regional, federal, and international jurisdictional boundaries combine with these management plans to create a complicated administrative environment. This administrative environment is not conducive to the development and siting of important emerging technologies, like offshore wind farms, requiring the agreement of multiple agencies, interests, and mandates. Because of the importance of Maine's ocean resources, it is imperative for Maine to adopt an effective management and planning policy that can dynamically adapt to new issues and incorporate new technologies. We recommend that Maine adopt an ocean governing structure similar to a proposed National Ocean Council by President Obama's Interagency Ocean Policy Task Force to effectively integrate issue and species-specific plans into ecosystem-based approaches to management.

In *The State of Rivers and Dams*, we find that the 31,752 miles of rivers and streams in Maine are important to Maine's economy, ecological health, and cultural heritage. Dams have shaped both the natural flows and the societal uses of rivers in Maine for over two centuries. Although no new dams have been built since 1986, remaining dams continue to have environmental and economic impacts. In this chapter we discuss the state of rivers and dams in Maine, focusing on the history of dams, their current status, and the growing trend of dam removal. We give particular attention to diadromous – or migratory – fish and how dams and dam removals affect their traditional migration routes. We conducted an extensive literature review and performed original analysis using Geographic Information Systems. This chapter shows that Maine's surface water quality is commendable, ranking number one in the U.S. We illustrate the growth of the number of dams in Maine over time, and investigate a boom in dam construction between 1875 and 1900. We also examine dam removal, a contentious topic, in light of the federal and state regulatory processes and the environmental benefits and drawbacks of dams. Finally, we analyze the historical habitat of 12 species of diadromous fish and find that 65% of dams that have been removed in Maine, or are slated for removal in the near future, intersect the habitats of six or more species while less than 1% of dams still standing intersect the habitats of six or more species . We conclude that while Maine's river health is in excellent condition, more can be done to allow diadromous fish populations renewed access to their historical habitat and spawning grounds. Although fish bypasses are feasible, only a small percentage of migrating fish find the necessary entrance. Dam removal is an increasing trend and should be considered as a viable option to restore diadromous fish habitat and spawning grounds. We offer several recommendations to increase river health and productivity, including the continued monitoring of river and stream health, a state-wide prioritization of dams to consider for fish bypass installation, and an increased emphasis on dam removal as a method for river restoration and public safety.

In *The State of Organic Agriculture*, we examine trends in overall agriculture and changes in organic production over time in Maine relative to other states, primarily using USDA Census of Agriculture statistics. Additionally, we use a Geographic Information System (GIS) to map locations of organic farms in Maine certified by the Maine Organic Farmers and Gardeners Association (MOFGA). We find that Maine, although a relatively small state in overall agricultural production, is a national leader in organic agricultural production. We examine reasons for this status and discuss future scenarios for organic agriculture in Maine. We also consider benefits and drawbacks of having national organic standards. We conclude that although organic production in Maine requires continued support, Maine policy makers could also promote growth in agriculture by further encouraging local consumption

of Maine produced foods. Additionally we recommend that Maine increase efforts to conserve farmland by supporting organic farmers in the state and helping to protect them from development pressures.

In *The State of Sustainable Communities*, we find that sustainable development requires reconciling competing environmental, economic, and social interests. Local governments are increasing efforts to address sustainability issues in response to perceived federal inaction. Maine currently lacks a method to effectively measure and encourage local sustainability activity. In response, we developed a prototype Sustainability Activity Index (SAI) to measure the seriousness with which Maine towns and cities are addressing energy and recycling issues. We evaluated energy and recycling scores for 476 Maine municipalities and found a low level of local activity, with a state-wide mean SAI score of 1.56 (SD ± 1.05) out of 8 possible points. We found that local governments with high SAI scores have larger budgets, are adjacent to postsecondary institutions, and have higher median household incomes and college graduation rates. We conclude that our SAI serves as a useful tool for comparing sustainability activity across Maine communities. We recommend the state delegate responsibility to a governmental or non-governmental entity that could publish SAI scores for all 489 incorporated municipalities in Maine. We recommend the responsible entity improve our SAI by engaging relevant stakeholders to create and publish an annual "Maine Local Government Sustainability Report Card" that is effective, robust, relevant, and transparent.

Acknowledgements

This report could not have been done without the help and guidance of many people, and we are deeply grateful to all of you. First, and foremost, we thank our professor, Phillip Nyhus for, among so many other things, providing seeds of ideas and the combined nurturing and mentorship along the way that has allowed for the growth of this report. In addition to the following experts and Colby staff, we would like to thank our friends and family for their continued support throughout this process.

Colby Faculty and Staff

Philip Nyhus Assistant Professor of Environmental Studies
Manny Gimond GIS and Quantitative Analysis Specialist
Jason Parkhill Academic Information Technology Services
Beth Kopp Environmental Studies Coordinator
Russ Cole Chair, Environmental Studies Program
Andrew W. Mellon Foundation

Field Experts

George LaPointe Commissioner of the Maine Department of Marine Resources
Seth Barker Department of Marine Resources
Ted Ames Penobscot East Resource Center
Neal Allen Executive Director, Greater Portland Council of Governments
Sandy Amborn Intern, Sierra Club – Maine Chapter
Norm Anderson Environmental Health Consultant
Melissa Ann Boyd University of Southern Maine
Andy Burt Maine Council of Churches
Bob Clark Northern Maine Development Commission
Judy East Washington County Council of Governments
Justin Holmes MidCoast Council of Governments
Lana LaPlant-Ellis State Planning Office: Waste Management and Recycling Program
Steve Linnel Greater Portland Council of Governments
Tara Pierce University of New Hampshire
Joan Saxe Maine Partners for Cool Communities
Paul Schumacher Southern Maine Regional Planning Commission
Missie Stults ICLEI – Local Governments for Sustainability
Joanna Taatjes Bowdoin College
Jacomijn Gardei MOFGA Certification Services, LLC.
CR Lawn FedCo Seeds

Spencer Aitel Two Loons Farm; MOFGA Board Member
Sam Hayward Fore Street Restaurant; MOFGA Board Member
Tim Christensen Colby Biology Department; MOFGA Member
Heather Albert-Knopp College of the Atlantic Program Administrator; MOFGA Board Member
Emma Balazs Snakeroot Farm
Rachael Katz Smith Farm
Andy Smith Colby Organic Garden
Ben Hummel Colby Organic Garden
Joe Klaus Director Colby Dining Services
Jeff McCabe House Representative (D-Skowhegan)
Bob Batteese Department of Agriculture
Rick Kersbergen University of Maine Cooperative Extension
David Gulak Barrels Community Market
Stacy VanDeveer Department of Political Science, University of New Hampshire
Tim Vrabel Deputy Director, Efficiency Maine
Sheri Walsh Administrative Assistant, Hancock County Planning Commission
Ken Young Kennebec County Council of Governments
Tony Fletcher Maine Emergency Management Agency
Andrew Goode Atlantic Salmon Federation
Bob Houston Gulf of Maine Coastal Program
Chad P. Clark NextEra Energy Resource
Dana P. Murch Maine Department of Environment Protection

State of Coastal and Marine Management in Maine

By John Abbett and Chris Englert

Executive Summary

The State of Coastal and Marine Management in Maine 2009 is the first chapter in *The State of Maine's Environment 2009*, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report published since 2004.

Maine's coastal and marine (ocean) resources play a vital role in the health of Maine's economy. In 2007, Maine's coastal municipalities employed 55% of the state's population and accounted for 60% of the state's gross domestic product (GDP). The vitality and character of these municipalities are at risk if the state's coastal and marine economic resources are degraded. Presently, threatened resources such as Maine's sea urchin and sea scallop fisheries are managed by the state and federal governments in a series of issue and species-specific management plans. The spatial boundaries of these plans geographically overlap, creating a network of interconnecting regions, management strategies, and authorities. In our assessment, we found that 68% of the geographical area in Maine's state waters is characterized by having 10 or more overlapping management zones and regulatory bodies.

Further regional, federal, and international jurisdictional boundaries combine with these management plans to create a complicated administrative environment. This administrative environment is not conducive to the development and siting of important emerging technologies, like offshore wind farms, requiring the agreement of multiple agencies, interests, and mandates. Because of the importance of Maine's ocean resources, it is imperative for Maine to adopt an effective management and planning policy that can dynamically adapt to new issues and incorporate new technologies. We recommend that Maine adopt an ocean governing structure similar to a proposed National Ocean Council by President Obama's Interagency Ocean Policy Task Force to effectively integrate issue and species-specific plans into ecosystem-based approaches to management.

Introduction

The State of Coastal and Marine Management in Maine is the first chapter in *The State of Maine's Environment 2009*, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report published since 2004.

Background

The world's coastlines and oceans are globally important. Coastlines (commonly defined as areas within 100 km of the land-sea boundary) provide human societies with highly-valued ecosystem services such as erosion control, nutrient cycling, waste treatment, and storm protection (Carter 1988, van der Meulen et al. 2004). These services are estimated to be valued globally at some $\$2.0 \times 10^{15}$ (Martinez et al. 2007). Covering just 10% of the earth's land surface, the coastlines are crowded with over 3.2 billion residents, and rising (Hinrichsen 1998). In the United States alone, coastal populations are expected to increase by 25 million people from 2003 to 2015 (Pew Oceans Commission 2003). As a result, nearly one-third of the coastline in North America is under moderate to high threat from the impact of development (Figure 1.1; Goulder and Kennedy 1997).

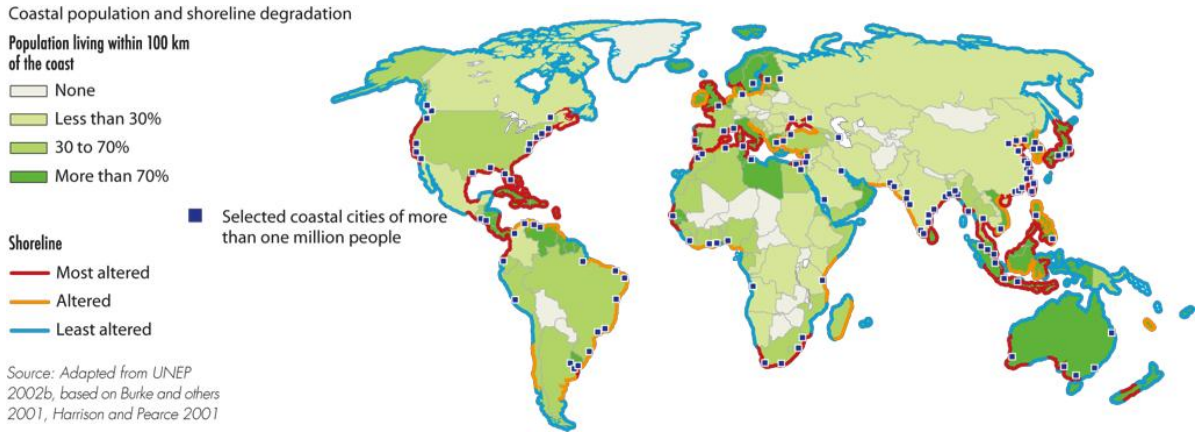


Figure 1.1 Coastal population versus shoreline degradation. Areas with higher coastal population generally link to a more altered state of shoreline. Reproduced with permission from Bounford.com and UNEP/GRID-Arendal http://maps.grida.no/go/graphic/coastal-population-and-shoreline-degradation

The world's oceans cover approximately 71% of the earth's surface and contain 97% of the planet's water (NOAA 2009). Oceans controlled by the U.S. span an area 23% larger than its land area (Pew Commission 2003).

The oceans are valuable to all people, driving vital global environmental services such as the water cycle (USGS 2009), primary oxygen production (Nielsen 1951), and climate regulation (Pew Commission 2003, NOAA 2009). Like the coasts, the world's oceans are threatened by human use. Most of the world's marine fish stocks, 75-80%, are depleted or fully exploited with 20% being moderately exploited (FAO 2009). Advances in fishing technology continue to increase exploitation of ocean resources further offshore, extending the reach of human impact (Courtney and Wiggins 2003). The oceans' waters face threats from eutrophication (Smith 2002), untreated disposal of human sludge, unregulated ballast waters from ships, and invasive species (Gorman 1993, UNEP 2007). Warming global temperatures also result in ocean acidification and rising sea levels from thermal expansion and melting land-ice (IPCC 2007).

Growing concern by governments at the state, national, and international levels over the declining conditions of the world's coastlines and oceans has manifested itself with a series of coastal and ocean management schemes around the globe. International agreements have resulted in jurisdictional boundaries off the shores of coastal countries (UN 1982); national efforts by the U.S. have created agencies and commissions to manage coastal and ocean resources (i.e. Atlantic States Marine Fisheries Commission, and National Marine Fisheries Service); and regional and local efforts by the state of Maine and other Atlantic coastal states have resulted in an assortment of marine management councils, plans, and programs (i.e. Lobster Zone Management Councils, Scallop Advisory Council, and Maine Coastal Program). These have resulted in a variety of management strategies including closed marine areas, limited fishing seasons, and restricted numbers of harvesting licenses.

Focus of This Chapter

"…we have continued to approach our oceans with a frontier mentality. The result is a hodgepodge of ocean laws and programs that do not provide unified, clearly stated goals and measurable objectives. Authority over marine resources is fragmented geographically and institutionally. Principles of ecosystem health and integrity, sustainability, and precaution have been lost in the fray."

Pew Ocean Commission 2003 p. viii

"Given the wide variety of uses and activities in the coastal zone, it is not surprising that there is a complex mosaic of management. Municipal, state and federal authorities often overlap in the same geographic coastal space. The regulation of certain activities may require the involvement of multiple agencies at multiple levels of government."

Maine Department of Marine Resources 2007 p. 14-15

In this chapter, we investigate three questions on coastal and marine management in the state of Maine. First, how are coastal and marine resources important to Maine? In particular, what are the contributions of coastal and marine resources in Maine's economy? Second, who manages Maine's coastal and marine resources, and how do the accompanying laws and regulations interact? And third, how does the current management system affect new use development, specifically, offshore wind farms?

We begin this investigation by discussing the importance of coastal and marine resources in Maine. We then summarize the laws and stakeholders implementing and contributing to coastal and marine resource management. Our initial investigation of these sections revealed a complex, piecemeal, overlapping system of coastal and ocean management similar to the quotes included above. Therefore, we continued our investigation with a focus on the geographical and spatial distribution of this complex regulatory system.

Using our spatial analysis of the regulatory system, we study the impact of the current management framework on the development of new coastal and ocean uses, specifically, offshore wind farms. We also look to the future of coastal and marine policy as a proposed National Ocean Policy is currently working its way through the federal government. We assess Maine's readiness for and possible impact from a transition to a National Ocean Policy by concluding with three scenarios for the future of Maine's coastal and marine policy, and with recommendations from our findings.

Methods

We gathered our data through a thorough literature review using Academic Search Premier, Web of Science, Google Scholar, and additional resources available in the Colby College Library and Interlibrary Loan Network. Our primary sources of data were government reports and documents, with journal articles, books, and agency websites providing supplemental material. At the state level, we used documents published by the Maine Department of Natural Resources (DMR) and the Maine State Planning Office (SPO). At the federal level, we used published documents from the Energy Information Agency (EIA), National Oceanic and Atmospheric Administration (NOAA), and the Interagency Ocean Policy Task Force, to name a few. In addition, we contacted five relevant government agencies and programs for data and interviews. We spoke personally with George Lapointe, Commissioner of the DMR, regarding the complex management system in the Gulf of Maine. We discussed the inherent difficulties for fisheries management and siting offshore wind farms. Commissioner Lapointe and Seth Barker from the DMR reviewed a draft of our maps and supplied us with additional data to improve the accuracy and effectiveness of these figures. We visited Stonington, Maine to meet with Ted Ames and Walter Reed of the Penobscot East Resource Center. We toured the Stonington fishery in Penobscot Bay aboard Ted Ames' lobster boat, the Mary Elizabeth. We also viewed video and read transcripts of the November 4, 2009 Senate Commerce subcommittee hearing entitled "The Future of Ocean Governance: Building Our National Ocean Policy."

We used Geographic Information System (GIS) to visually represent and analyze spatial data obtained from the Maine Office of GIS including state boundaries and bathymetry. We obtained resource management boundary data from the Maine Department of Marine Resources, NOAA Office of Coast Survey, National Marine Sanctuary Library, and Turnipseed et al. *Science* journal article. Population data were obtained from the US Census Bureau. We used ArcGIS software (ESRI 2009) to digitize and georeference paper maps. We drew management boundaries with polygons to form new layers. We were able to analyze the type, size, and location of management boundaries from our data sources. Using GIS tools, we calculated the areas of overlapping jurisdictions. We encountered differences among the management boundaries between multiple data layers. These are visible in the jurisdictional water's map (Figure 1.5) and our overlapping zone density map (Figure 1.12); however, we feel the spatial analysis based on this figure is sufficiently accurate for the level of analysis we conducted.

Importance of Coastal and Marine Resources in Maine

Coastal and ocean resources are perhaps the most identifiable features of Maine's heritage, economy, and demographics (SPO and DMR 2007). Maine's coast covers more than 5,000 miles with nearly two million acres of public submerged lands. Maine's population density is highest along the coast and continues to grow, but this growth is not even (Figure 1.2). From 1960-2000, the Downeast region, which runs from Penobscot Bay to the Canadian border, has had slow to negative growth, whereas the Mid-coast region from western Penobscot Bay to the northern coastal municipalities of Cumberland county, has had slightly higher growth. The Southern region has the highest rates of growth.

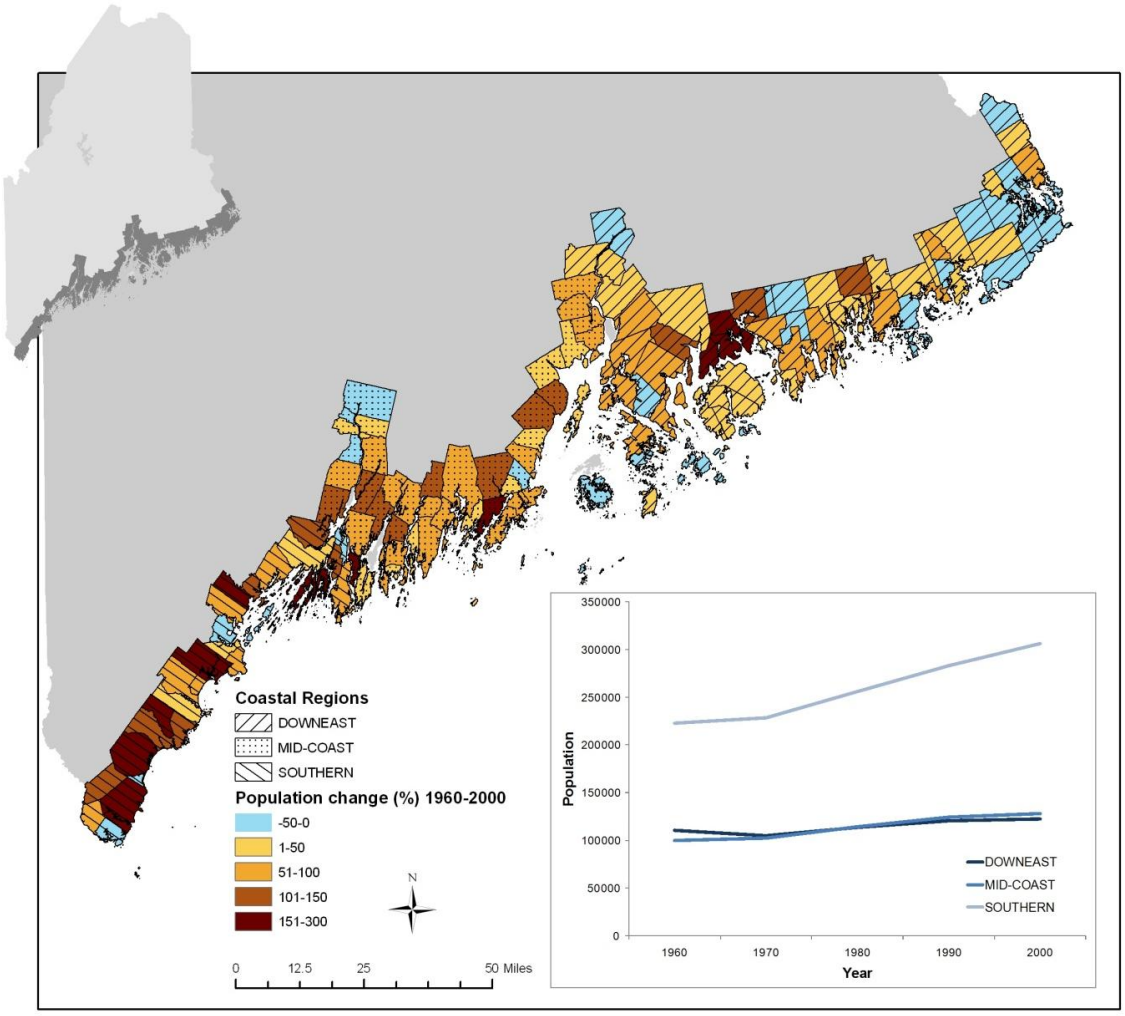


Figure 1.2 Population change in Maine's coastal municipalities. The line graph compares population change from 1960 to 2000 in Downeast, Mid-coast, and Southern municipalities. The Southern region has had the highest amount and rate of growth. (Data source: US Census Bureau).

Maine's waters have always provided its people with food, transportation, and economic growth (SPO 2007). In 2004, the coastal economy of Maine directly employed an estimated 45,685 people and resulted in roughly $1.2 billion in annual wages (Colgan 2009). In 2007, coastal municipalities accounted for 55% of the state's employment (NOEP 2009). This 55% generated 59% of the wages earned and 60% of the state's GDP. Maine's ocean economy, which includes marine transportation, tourism and recreation, living marine resources, marine construction, ship and boat building, and mineral extraction, grew 185% from 1990-2007 (NOEP 2009). Maine outpaced the rest of New England in the rise of its ocean economy GDP (Figure 1.3).

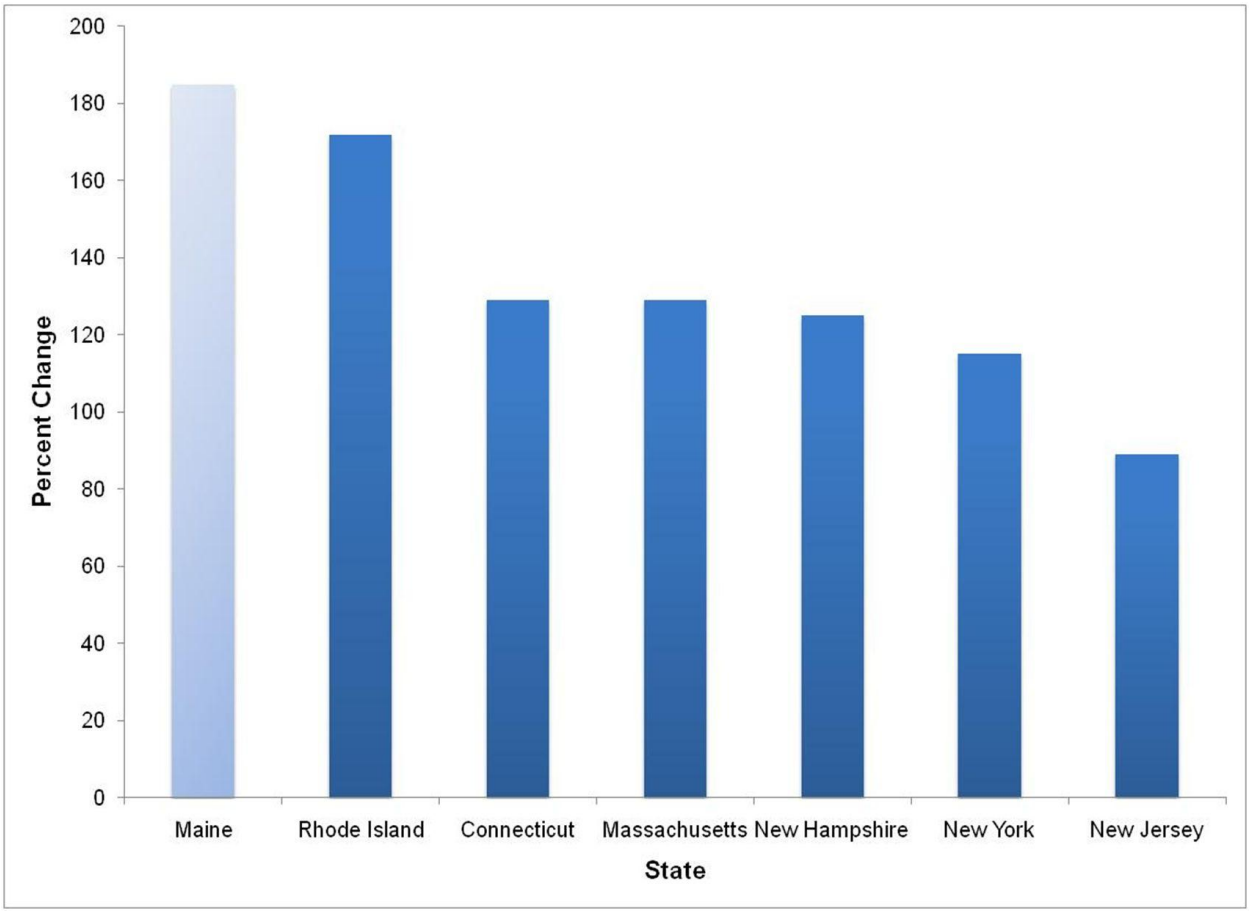


Figure 1.3 New England states' percent change in Ocean GDP from 1990-2007. Maine has the highest growth rate in ocean GDP. (Data source: NOEP 2009).

Although Maine's ocean economy has the largest growth rate in GDP from 1990-2007, Maine's coastal economy is lagging behind the rest of the nation when it comes to percent change in coastal GDP from 1990-2007 (Figure

1.4). Maine's coastal GDP grew 216% from 1990 to 2007, yet ranks 24th out of 28 amongst all coastal states (including states that border the Great Lakes).

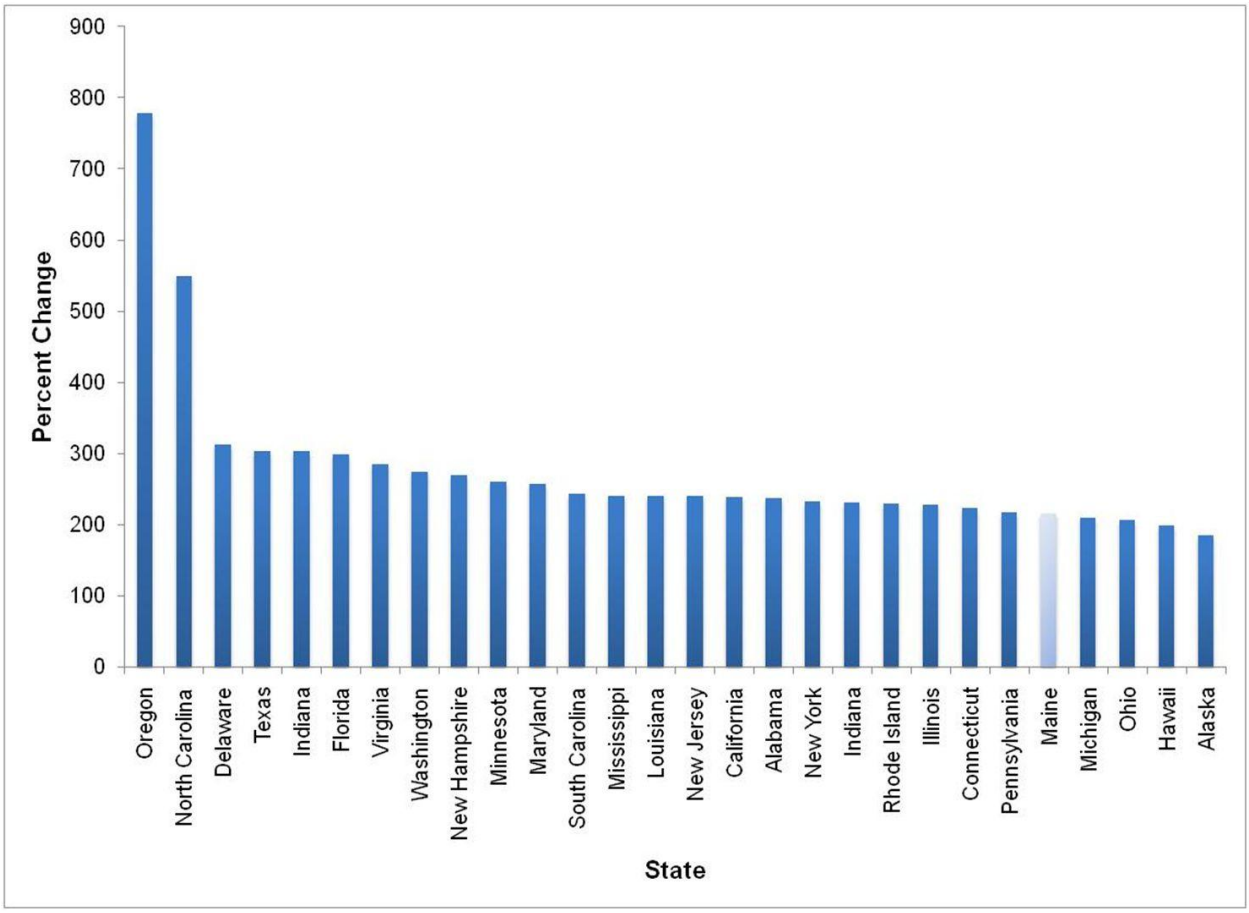


Figure 1.4 Percent change in coastal GDP from 1990-2007. Maine's coastal economy ranks 24th out of 28 states. (Data source: NOEP 2009).

Maine's coastal economy has shifted in the last couple decades. Growth has occurred in the financial, education, health, and business services sectors while coastal communities in Maine have experienced a net decrease in manufacturing, construction, natural resource mining, and other services (NOEP 2009). The largest growth was in the financial sector with an increase of 6.33%, followed by the education and health sectors, which grew at 5.5% from 1990 to 2007. The largest decrease came from the manufacturing sector, which decreased 6%, followed by public administration sector (1.8%) and construction sector (1.6%).

While Maine continues to rely on its coastal communities for economic stability, ocean uses are changing, diversifying, and intensifying (SPO and DMR 2007). In some areas, fishing boats are being replaced by sea kayaks and other recreational watercraft; aquaculture has become economically significant alongside traditional capture methods; second-home buyers and retirees are replacing fishing families; and energy infrastructure is being developed in Maine's waters and coastal communities (State of Maine 2008, SPO and DMR 2007).

Legislation

In this section, we focus on 14 laws that affect Maine's management of its coastal and marine resources; however, these are only a fraction of the more than 140 laws that pertain to the oceans and coasts at the federal level alone (Pew Commission 2003). We selected these laws to supplement our GIS spatial analysis. These laws designate marine jurisdictions, establish state management councils, as well as provide a number of additional management guidelines. The section is broken up into three sub-sections: International Agreements, Federal Laws, and State Laws. Table 1.1 and Table 1.2 summarize the key points of these laws and agreements. These laws directly affect the stakeholders we discuss in the next section.

International Agreements

The first level of regulation we investigate are international agreements. One of these agreements has particular relevance to Maine's coastal and marine resources: the United Nations Convention on the Law of the Sea.

United Nations Convention on the Law of the Sea (1982)

The United Nations Convention on the Law of the Sea (UNCLOS), also known as the Law of the Sea Convention or the Law of the Sea Treaty, is an international agreement resulting from the third United Nations Conference on the Law of the Sea (UN 1982). Of importance to Maine are the agreement's establishments of Exclusive Economic Zones (EEZ), Territorial Seas, and Contiguous Zones, as well as provisions for protection of transboundary fish stocks and highly migratory species, marine mammals, sea turtles, anadromous fish stocks, catadromous species, sedentary species, and marine habitat protection. UNCLOS came into force on November 16, 1994, and as of November 4, 2009, 159 countries had ratified the agreement. A notable exception from the list of ratified countries is the U.S. (UN 2009). Through a number of Presidential Proclamations, however, the U.S currently recognizes jurisdictional boundary provisions set forth in UNCLOS. Below, we summarize three of these boundaries.

Exclusive Economic Zone

A nation's Exclusive Economic Zone (EEZ) extends 200 nautical miles from the baseline mean low water mark (UN 2009). Within these zones, a coastal nation has sole exploitation rights over all marine resources. Other nations may exercise freedom of vessel navigation and over-flight. The U.S. 200-mile EEZ was established by Presidential Proclamation 5030 on March 10, 1983.

Territorial Sea

The Territorial Sea is recognized internationally as the waters 12 nautical miles out from the mean coastal low-water mark (UN 2009). The territorial sea is considered part of a country's sovereign territory, and therefore the country has rights to the air space, water column, seabed, and subsoil found within the 12-mile limit. Other international laws related to innocent passage, transit passage, and protection of the marine environment apply in these waters. Presidential Proclamation 5928 established the U.S. territorial sea on December 27, 1988.

Contiguous Zone

The contiguous zone extends an additional 12 miles seaward of the territorial sea to 24 nautical miles from the baseline low water mark (UN 2009). The contiguous zone is a buffer zone in which coastal nations may use authority over foreign vessels to prevent infringement of customs, fiscal, immigration, sanitary, and pollution laws and regulations. The contiguous zone helps protect Maine's efforts in marine management from infringement by a foreign country. Presidential Proclamation 7219 established the U.S. contiguous zone on September 2, 1999.

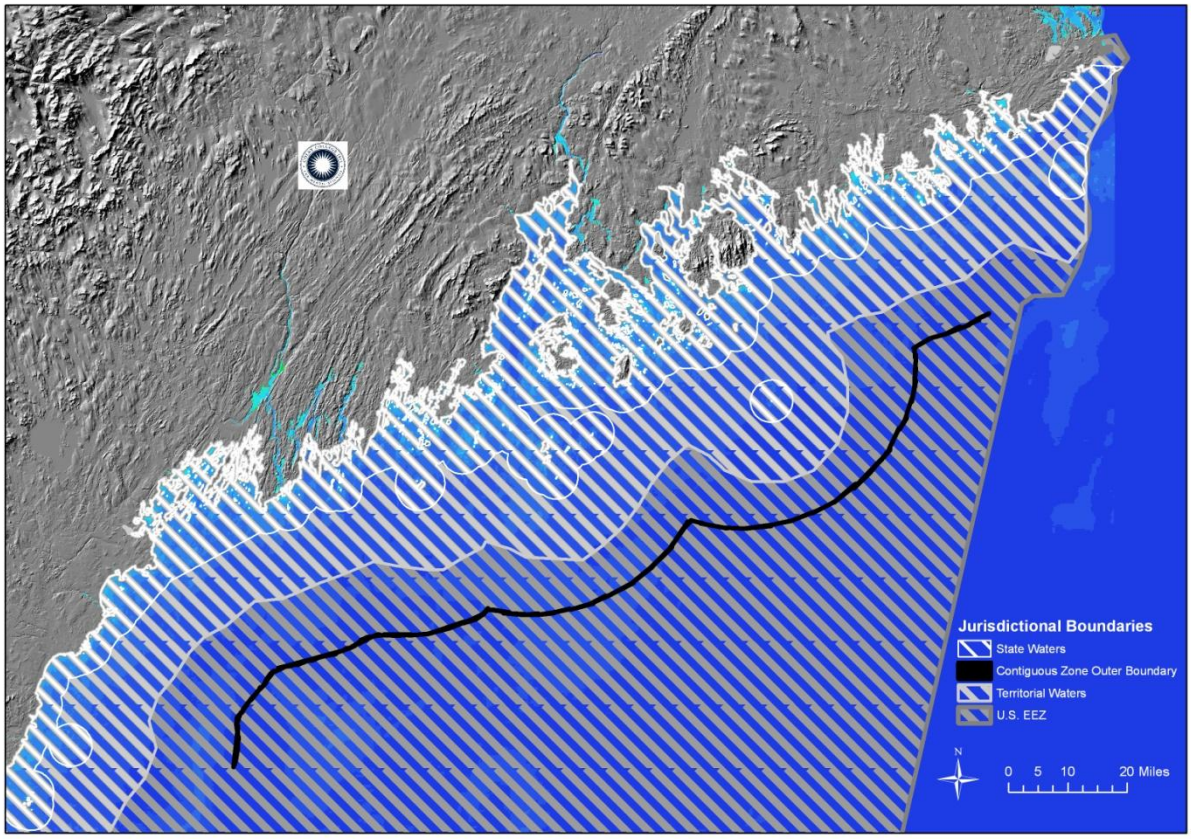


Figure 1.5 Marine jurisdictional boundaries in the Gulf of Maine. State waters extend to three nautical miles, territorial waters extend between three to 12 nautical miles, the contiguous zone extends from 12 to 24 nautical miles, and the EEZ extends to 200 nautical miles. (Data source: Maine Office of GIS, NOAA Coast Survey).

Federal Laws

There are over 140 federal laws that pertain to the oceans and coasts (Pew Commission 2003). In this section, we describe six of these laws that directly pertain to either management boundaries or the regulation of coastal and marine resources.

The Submerged Lands Act (1953)

The Submerged Lands Act (SLA) granted states title to the natural resources (oil, gas, and all other minerals) located within three miles of their coastline (43 U.S.C. § 1301-1315). The federal government maintains the right to regulate offshore activities for national defense, international affairs,

navigation, and commerce (NOAA 2009b). This three-mile boundary is visualized in Figure 1.5.

Coastal Zone Management Act (1972)

The Coastal Zone Management Act (CZMA) was enacted by Congress in 1972 (16 U.S.C. § 1451-1456) with the intent to balance coastal natural resource protection with economic development. The legislation provides states with federal assistance for those who develop and maintain a comprehensive management plan for their coastal jurisdiction or a Coastal Zone Management Plan (CZMP) as reviewed by the National Oceanic and Atmospheric Administration (NOAA) (Klee 1999). A CZMP has to address the CZMA's five objectives: protect and preserve coastal ecosystems, manage coastal development, improve water quality, utilize economic and energy resources, and coordinate and simplify administrative procedures. Maine's most recent edition of its "Maine Coastal Plan" was submitted and approved by NOAA in 2006 (SPO 2006b).

Atlantic States Marine Fisheries Compact (1942)

The Atlantic States Marine Fisheries Compact established the Atlantic States Marine Fisheries Commission (ASMFC) in recognition that fish do not adhere to political boundaries, and therefore no state by itself can effectively protect the interests of its citizens (12 U.S.C. § 4601-4656). The Commission is made up of 15 states, each represented by 3 members. Currently, the chair of the ASMFC Commissioners is the Commissioner of Maine's Department of Marine Resources (ASMFC 2009). The Commission participates in five main policy issues: interstate fisheries management, research and statistics, habitat conservation, sport fish restoration, and law enforcement. The Commission's vision is for healthy, self-sustaining fish populations for all Atlantic coast fish species or to have successful restoration well in progress by the year 2015. Each state must work with the Commission states and the federal government to conserve and manage coastal fisheries. The most recent management programs are the Five-Year Strategy Plan (2009-2013) and the Habitat Program Five-Year Strategic and Management Plan (2007-2011) (ASMFC 2009).

Atlantic Coastal Fisheries Cooperative Management Act (1993)

The Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) was enacted to ensure that the Atlantic coastal states are compliant with the conservation measures approved by the Atlantic States Marine Fisheries Commission (16 U.S.C. § 5101-5108). ACFCMA provides assistance to the Atlantic States Marine Fisheries Commission in order to support and

encourage the development, implementation, and enforcement of effective interstate conservation and management of Atlantic Coastal resources (ASMFC 2009).

Fishery Conservation and Management Act - Magnuson-Stevens Act (1976)

The Magnuson-Stevens Act (MSA) granted federal authority for fisheries management to NOAA's National Marine Fisheries Service (16 U.S.C. § 1801-1884). Eight regional fishery management councils were established to implement regional fishery management plans. Maine falls within the Northeast Regional Office, located in Gloucester, MA.

Sustainable Fisheries Act (1996)

The Sustainable Fisheries Act (SFA) is an amendment to the MSA (16 U.S.C. § 1801-1882). The Sustainable Fisheries Act includes provisions requiring science, management, and conservation action be taken by the National Marine Fisheries Service (Office of Sustainable Fisheries, NOAA Fisheries 2009).

Table 1.1

Law	Year	Description	Location
Submerged Lands Act	1953	Granted states title to the natural resources (oil, gas, and all other minerals) located within three miles of their coastline	USC Title 43 § 1301-1315
Coastal Zone Management Act	1972	Provided states with federal assistance for those who develop and maintain a comprehensive management plan for their coastal jurisdiction or a Coastal Zone Management Plan as reviewed by the National Oceanic and Atmospheric Administration.	USC Title 16 § 1451-1456
Atlantic States Marine Fisheries Compact	1942	Established the Atlantic States Marine Fisheries Commission in recognition that fish do not adhere to political boundaries, and therefore no state by itself can effectively protect the interests of its citizens.	USC Title 12 § 4601-4656
Atlantic Coastal Fisheries	1993	Enacted to ensure that the Atlantic coastal states are compliant with the conservation measures approved by the	USC Title 16 § 5101-5108

Cooperative Management Act		Atlantic States Marine Fisheries Commission of effective interstate conservation and management of Atlantic Coastal resources.	
Fishery Conservation and Management Act - Magnuson-Stevens Act	1976	Granted federal authority for fisheries management to NOAA's National Marine Fisheries Service. Eight regional fishery management councils were established to implement regional fishery management plans.	USC Title 16 § 1801-1884
Sustainable Fisheries Act	1996	Includes provisions requiring science, management, and conservation action be taken by the National Marine Fisheries Service	USC Title 16 § 1801-1882

State Laws

Mandatory Shoreline Zoning Act (1971)

The Mandatory Shoreline Zoning Act or the "Shoreline Zoning" law requires all municipalities to create zoning ordinances for areas within 250 feet of the high water line of any body of water, river, wetland, and coastline (MRS Title 38 Chapter 3 § 439-449). If a municipality does not establish its own zoning ordinances, the state holds the right to develop a zoning plan for the area.

Lobster Management Zones and Councils (1995)

The Lobster Management Zones and Councils were established in 1995 through the state legislature with subsequent amendments last being added in 2007 (MRS Title 12 Chapter 619 § 6446-6477). The zones were created by the Commissioner of Marine Resources to facilitate local or regional management of lobster fishery efforts. Seven management zones were created. Each zone is represented on the Council. The Council advises the commissioner on activities of the department that relate to the lobster industry. On an application for a Class I, Class II, Class III or noncommercial lobster license or a nonresident lobster permit, a person shall declare the lobster management zone in which that person proposes to fish a majority of that person's lobster traps and shall list all other zones in which that person proposes to fish. The license holder must identify the declared lobster zone in which a majority of that person's lobster traps is authorized to fish. A person may not place any lobster traps in a zone that is not identified on that person's license.

Sea Urchin Zone Council (1993)

In 1993, state legislation established the beginnings of a Sea Urchin Zone Council, and established two Sea Urchin Management Zones (MRS Title 12 Chapter 623 6749-X). The legislation was amended in 2007, creating a council of 15 members. Seven of the Council members are elected by the sea urchin industry. The Commissioner of the Marine Department of Marine Resources appoints the remaining eight members. The Council and management zones are described in more detail in the State of Topic section of this report.

Scallop Advisory Council (2003)

The Scallop Advisory Council was formed through Maine legislation in 2003 (MRS Title 12 Chapter 623 § 6729-B). The Council consists of 13 members. Similar to the Sea Urchin Zone Council, the Scallop Advisory Council advises the Commissioner of DMR on issues related to seasons, closings, size restrictions, and daily limits. The Council is described in more detail in the State of Topic section of this report.

Maine Wind Energy Act (2003)

Maine Wind Energy Act (MRS Title 35-A Chapter 34 § 3404(2)(B)) established state goals regarding wind energy. The Maine Wind Energy Act established policy that finds wind energy to be in the best interest of the state thereby making it a priority for state agencies to encourage wind development. It sets the goal to meet or exceed 2,000 megawatts of wind capacity by 2015 and least 3,000 megawatts by 2020. It also sets the goal to for offshore wind, which is 300 megawatts by 2020.

Public Trust Doctrine

The State of Maine holds state-owned submerged lands (lands below mean low-tide line out to 3-mile limit) in trust for the benefit of the people of Maine (SPO and DMR 2007). In accordance with this common law, the State manages these lands and the natural resources in the public interest. The uses and interests recognized by the Public Trust Doctrine include commerce, fishing, navigation, recreation, and conservation. The doctrine establishes the responsibility of the state to manage these public trust assets to preserve and continuously assure the public's ability to fully use and enjoy public trust lands, waters, and resources for certain public uses (CSO 1997).

Table 1.2

Law	Year	Description	Location
Mandatory Shoreline Zoning Act	1971	Requires all municipalities to create zoning ordinances for areas within 250 feet of the high water line of any body of water, river, wetland, and coastline. The state holds the right to develop a zoning plan for municipalities not in compliance.	MRS Title 38 Chapter 3 § 439-449
Lobster Management Zones and Advisory Council	1995	Seven lobster management zones were created by the Commissioner of Marine Resources to facilitate local or regional management of lobster fishery efforts. Each zone is represented on the council. The council advises the commissioner on activities of the department that relate to the lobster industry.	MRS Title 12 Chapter 619 § 6446-6477
Sea Urchin Zone Council	1993	Established a Sea Urchin Zone Council, and two Sea Urchin Management Zones.	MRS Title 12 Chapter 623 § 6749
Scallop Advisory Council	2003	The Scallop Advisory Council consists of 13 members acting as advisors to the Commissioner of MDMR on issues related to seasons, closings, size restrictions, and daily limits.	MRS Title 12 Chapter 623 § 6729
Maine Wind Energy Act	2003	Established policy that finds wind energy to be in the best interest of the state thereby making it a priority for state agencies to encourage wind development.	MRS Title 35-A Chapter 34 § 3404(2)(B)
Public Trust Doctrine		The State of Maine holds state-owned submerged lands (lands	

	below mean low-tide line out to 3-mile limit) in trust for the benefit of the people of Maine (SPO and MDMR 2007). In accordance with this common law, the State manages these lands and the natural resources in the public interest.

Stakeholders

The sustainability of Maine's coastal and marine resources depends upon successful management. This responsibility falls on many different federal, state, and local agencies along the coast and in the Gulf of Maine. There are also additional regional management partnerships which cross political boundaries and incorporate non-government stakeholders into the management process. There are also non-government stakeholders who are affected by the condition of coastal and marine resources yet do not have an active role in their management.

Government Agencies

In this section, we provide a list of stakeholders that are active in managing coastal and marine resources in the Gulf of Maine. The section is divided into three categories: federal, regional, state, and local. The categories are meant to distinguish between sources of funding and administrative control only, and are not meant to group the stakeholders in any hierarchal order.

Federal

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) provides scientific information on oceans and atmosphere for the purpose of managing marine resources. NOAA has various administrative and management responsibilities over coastal zone management (NOAA 2009).

There are three main NOAA offices that deal directly with issues pertaining to Maine's coastal and marine ecosystems and their management (NOAA 2009). The first office is the Fisheries Service, which includes the Northeast Fisheries Science Center, the Coastal and Marine Resources Program, and the Office of Restoration Center. The Fisheries Service: Northeast Fisheries

Science Center, located in Orono, ME, conducts research focused on living marine resources in the Gulf of Maine for NOAA's management purposes. The second office is the Coastal and Marine Resources Program (CMRP), which consists of a number of programs including the Coastal Zone Management Program, the National Estuarine Research Reserve System, the National Marine Sanctuaries Program, the Marine Protected Areas Center, the Coastal Services Center, the Cooperative Institute for Coastal and Estuarine Environmental Technology, and the Coastal and Estuarine Land Conservation Program. These programs work together to manage and protect coastal and marine ecosystems. The CMRP works with a number of different regional NOAA offices, partnerships, and cooperatives around the U.S. to apply ecosystem-based management approaches in accordance with the Coastal Zone Management Act, the National Marine Sanctuaries Act, and the Marine Protected Areas Executive Order. The third office is the Office of Restoration Center, the only NOAA office dedicated to restoring coastal, marine, and migratory fish habitats (NOAA 2009).

Environmental Protection Agency

The Environmental Protection Agency (EPA) is responsible for research, monitoring, standard setting, implementation, and enforcement of federal point source and nonpoint source pollution laws under the Clean Water Act (EPA 2009). Along Maine's coast, the EPA controls standards for developing best management practices for nonpoint source pollution as well as discharges, ocean dumping, and aquaculture. Maine participates in the EPA's National Estuary Program, established by the Clean Water Act Section 320, to improve the quality of estuaries through the Piscataqua Region Estuaries Partnership and the Casco Bay Estuary Partnership. Based upon the research funded through its Loan Grant Program which helps funds studies dealing with watershed protection and restoration as well as the results of pilot projects that test different management approaches in the Great Bay Estuary, the program establishes a Comprehensive Conservation and Management Plan for the Estuary (EPA 2009).

Fish and Wildlife Service

The Fish and Wildlife Service (FWS) controls the Gulf of Maine Coastal Program, located in Falmouth, ME, is one of 21 Coastal Program offices in the U.S. which focuses on identifying, protecting, and restoring threatened and endangered species (FWS 2009). Coastal programs leverage up to 25% of project costs using federal, state, and private funds. Since the early 1990's, the coastal program spent $43 million on conservation projects in Maine (FWS 2009).

United States Geological Survey

The U.S. Geological Survey (USGS) is a science-based government organization that collects data to support federal and state agencies as well as manage water and natural resource extraction (USGS 2009). The New England Coastal Basins study is one of more than 50 National Water Quality Assessment (NAWQA) Program studies in the U.S. The NAWQA Program's purpose is to monitor the status and trends in surface and ground water quality. NAWQA provides a basis on which regional and national-level policy decisions can be based regarding natural and human disturbances to water quality.

Regional

Gulf of Maine Council on the Marine Environment

The Gulf of Maine Council on the Marine Environment is a U.S.-Canadian partnership of government and non-government organizations whose goal is to maintain and improve the environmental quality of the Gulf of Maine (Gulf of Maine Council 2009). The state and providences involved are Massachusetts, New Hampshire, Maine, New Brunswick, and Nova Scotia. The Council awards grants and raises public awareness of relevant coastal/oceanic environmental issues.

Gulf of Maine Area Census of Marine Life

The Gulf of Maine Area (GOMA) program performs regional ecosystem research as an arm of the Census of Marine Life (CoML), an affiliate of the non-governmental Scientific Committee on Oceanic Research (SCOR) (GOMA 2009). The goal of the program is to develop an ecosystem-based management plan for the Gulf of Maine. This program is composed of American and Canadian scientists at the University of Southern Maine and the Centre for Marine Biodiversity.

State

State Planning Office

The Maine State Planning Office (SPO) is responsible for assisting the Governor and legislature by recommending long-term policies for the state including development and conservation plans (SPO 2009). This requires the SPO to conduct assessments of Maine's economy and natural resources. The SPO has two programs that deal specifically with management and

planning for Maine's coast. The Maine Coastal Program is administered by the SPO and is a partnership between federal, regional, state, and local agencies (SPO 2009). The program was developed and has been approved under the federal Coastal Zone Management Act (CZMA) since 1978. The Maine Coastal Program addresses Maine's coastal resources and coastal development by focusing on nine stated priorities: public access, coastal hazards, ocean resources, wetlands, cumulative and secondary impacts, marine debris, special area management planning, energy and government facilities siting, and aquaculture (SPO 2009). The Coastal Program provides data and maps, as well as guidance in projecting the effects of growth in municipalities, to municipalities for the purpose of planning for those effects. The other program, the Land Use Planning Program, is responsible for implementing the Growth Management Program, which reviews all land-use plans at the local level (SPO 2009). The Land Use Planning Program provides assistance to local governments when necessary (SPO 2009).

The Land and Water Resources Council was established in 1994 by Executive Order, then reaffirmed by Maine's Legislature through statute (5 MSRA § 3331 (2)), and is composed of the Commissioners and directors of eight state government departments (SPO 2009). The Council was created to coordinate the natural resource management plans of state agencies and serves in an advisory capacity to the Executive and Legislative branches of Maine state government (SPO 2009).

Department of Marine Resources

The Maine Department of Marine Resources (DMR) is responsible for Maine's marine resources (DMR 2009). They conduct and fund scientific research in addition to developing and implementing laws and regulations for marine resources on or under coastal waters. Within DMR, the Office of the Commissioner, Bureau of Sea-Run Fisheries and Habitat, Community Resource Development, Bureau of Marine Patrol, and Bureau of Resource Management all work on ongoing marine policy.

Department of Environmental Protection

The Maine Department of Environmental Protection's (DEP) main function concerning coastal areas is to review and give permits for both point source and nonpoint source pollution control and to monitor coastal wetland areas and shoreland zoning laws (DEP 2009). The DEP's goal is to prevent damage to the environment from pollution and development.

Department of Inland Fisheries and Wildlife

The Maine Department of Inland Fisheries and Wildlife (IWF) is concerned with fish and wildlife from an "intrinsic, ecological, scientific, economic, recreational, and educational point of view" (IFW 2009). In addition to scientific research, the IWF also assesses and reviews all proposed coastal development projects (IFW 2009).

Department of Conservation

The Maine Department of Conservation (MDOC) is in charge of Maine's publicly owned lands and is responsible for managing state-owned land (MDOC 2009). Maine's Ocean Energy Task Force (OETF) determined the MDOC is a key department in the siting and permitting process of offshore wind.

University of Maine

The University of Maine through the Maine Sea Grant funds scientific research that is related to the Gulf of Maine (Maine Sea Grant 2009). Grants are given to support marine and coastal scientific research and education. It is a state-federal partnership based at the University of Maine and is sponsored by NOAA and the State of Maine.

Local

Coastal Municipalities

Coastal municipalities are affected by all changes to resource management. Members of their communities are diverse and have stakes in coastal and marine resources including the development of those resources.

Non-Government Stakeholders

In this section, we briefly touch upon notable non-governmental stakeholders. These stakeholders do not directly affect our spatial analysis; therefore, we provide a short overview of only three broad stakeholders: fishing industry, offshore wind developers, and coastal municipalities. Non-government stakeholders do not actively manage the jurisdictional and resource management boundaries, but they influence and are directly affected by management related to coastal and marine resources.

Fishing Industry

Fisherman, processors and distributors are affected by changes to fishing regulations and boundaries. They are also affected by the productivity of the fisheries which is a byproduct fishery management strategy.

Offshore Wind Developers

Offshore wind developers are affected by the permitting process of offshore wind farms, controlled by state agencies. Developers are also affected by changes in state and federal subsidies for offshore wind. The Norwegian energy company StatoilHydro is the only commercial developer that has signed onto the proposed demonstration sites (DOC 2009).

State of Topic

Maine's Coastal and Marine Resource Management

In this section, we investigate the spatial distribution of Maine's multiple coastal and marine resource management plans. We begin by providing case studies into three resources: the Green Sea Urchin, the Atlantic Sea Scallop, and the Atlantic Herring. We provide these case studies to highlight the reactionary nature of Maine's management plans. These case studies also focus attention on the variety of implementation strategies currently managing resources in the Gulf of Maine. The laws and stakeholders outlined in the previous sections are the backbone and muscle of these management plans. Our research has identified eleven management plans in the Gulf of Maine (Figure 1.11). We give particular consideration to their overlapping geographical positions. The purpose of this investigation is to examine the complexity inherent in the current system. This section is not meant as an assessment of the health of Maine's fisheries. For a more in-depth look at the state of fisheries in Maine, please refer to the State of Maine's Environment 2008 Report (Casey, Chanin, Dufraine 2008).

Green Sea Urchins

Maine's green sea urchin fishery is the first of our three case studies. Sea urchins have been successfully harvested in Maine since prehistoric times (DMR 2004). Through the early 1980s, Maine's sea urchin catch was marginal and provided merely small, local markets in and around Boston. However, in 1987, a combination of powerful influences vitalized the urchin fishery. First, collapsing numbers of groundfish, such as the Atlantic cod, lowered the number of sea urchin predators, sparking growth in urchin populations. Second, the Japanese demand for sea urchin meat grew with

the yen gaining versus the dollar. Lastly, the advent of overnight shipping allowed harvests in Maine to reach the global sea urchin market (Ganong 2009).

The urchin fishery attracted harvesters like an underwater gold rush. By 1994, there were as many as 2,725 harvesters, yet there were minimal efforts to protect the vitality of the fishery (Clark 2008). Consequently, sea urchin harvests peaked at 41.6 million pounds in 1993 (Figure 1.6).

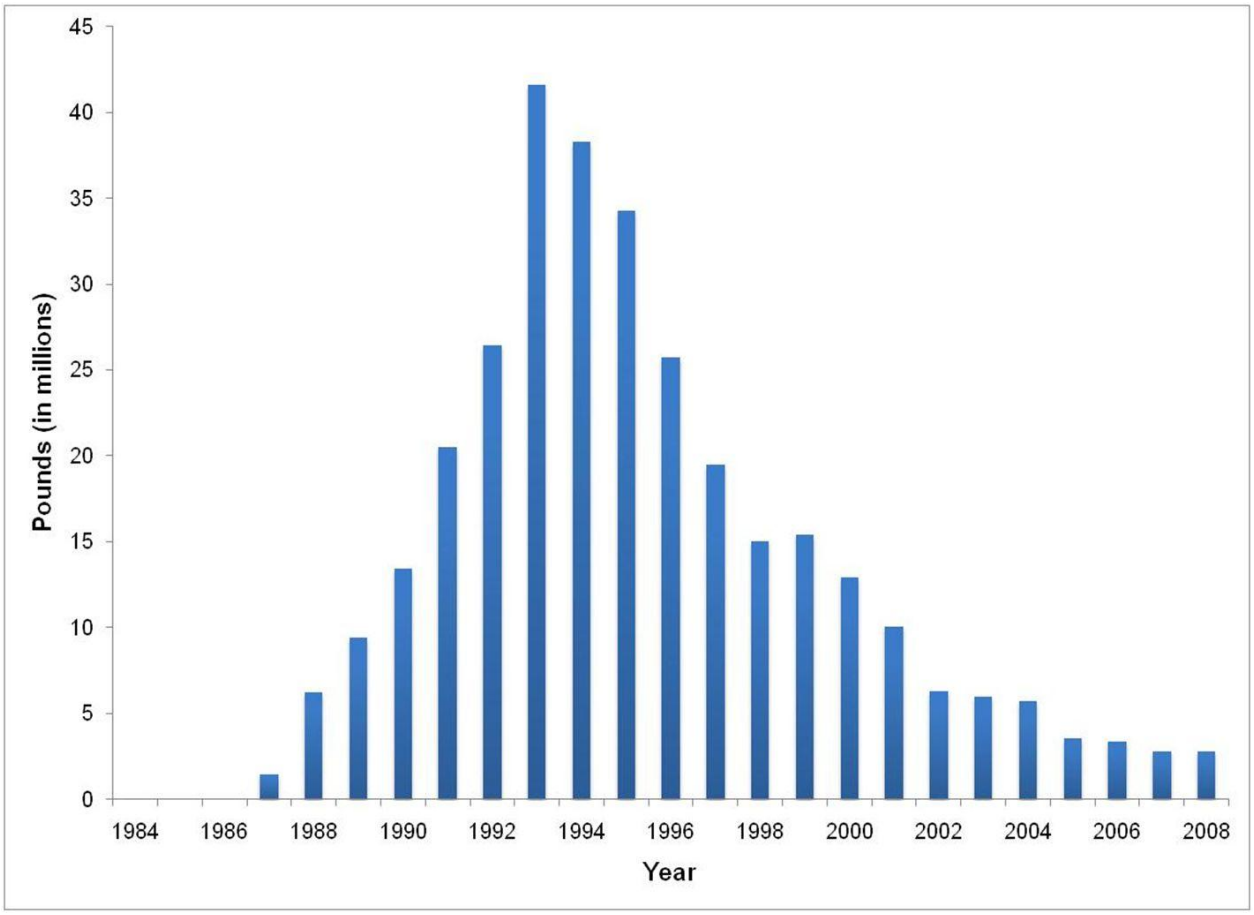


Figure 1.6 Changes in sea urchin harvest in the Gulf of Maine over time. The maximum harvest was 41.6 million pounds in 1993. The harvest has decreased each year since 1993. (Data source: DMR).

The fishery became regulated by Maine statute in 1993, having since been amended six times, most recently in 2009 (MRS Title 12, Chapter 623 §6749-X). The legislation established the Sea Urchin Zone Council, a regulatory body consisting of 15 members. Maine was split into two Sea Urchin Zones (Figure 1.9-C). Seven of the Council members are elected by the sea urchin industry: two hold a current handfishing license (one from each zone), two hold a current draggers license (one from each zone), two

hold wholesale licenses (one holds a sea urchin buyer's permit, one holds a processor's permit), and one harvester holds a current boat tender's license. The Commissioner of the DMR appoints the remaining eight members. The Council makes recommendations to the Commissioner concerning the designation of open days for harvesting, research projects and grants funded by the Sea Urchin Research Fund, and other matters of interest to the sea urchin fishery.

Management of the sea urchin fishery has aimed to limit harvesting efforts. This has manifested with shorter harvesting seasons (Figure 1.7) and reduced numbers of harvesting licenses (Figure 1.8). The upcoming 2009-2010 season is seeing the first increase in the number of open days in Zone 1 since the regulations were started after nearly two decades of steady declines.

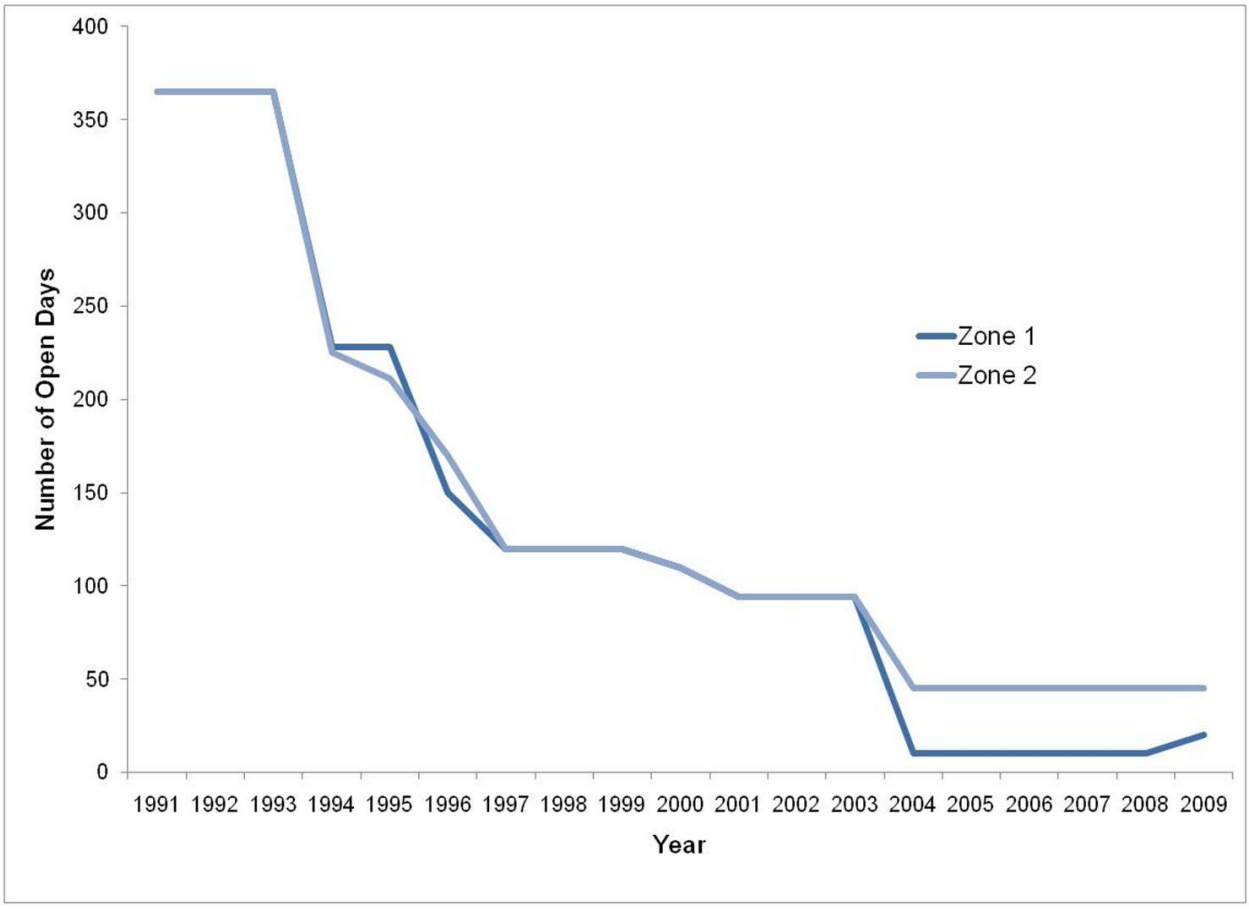


Figure 1.7 Number of open days in sea urchin harvesting season. Sea urchin harvesting days has declined overtime. Before 1994, no regulation was established, making the season 365 days. Difference in open days between zones is the result of stronger urchin resources in Zone 2. (Data source: DMR).

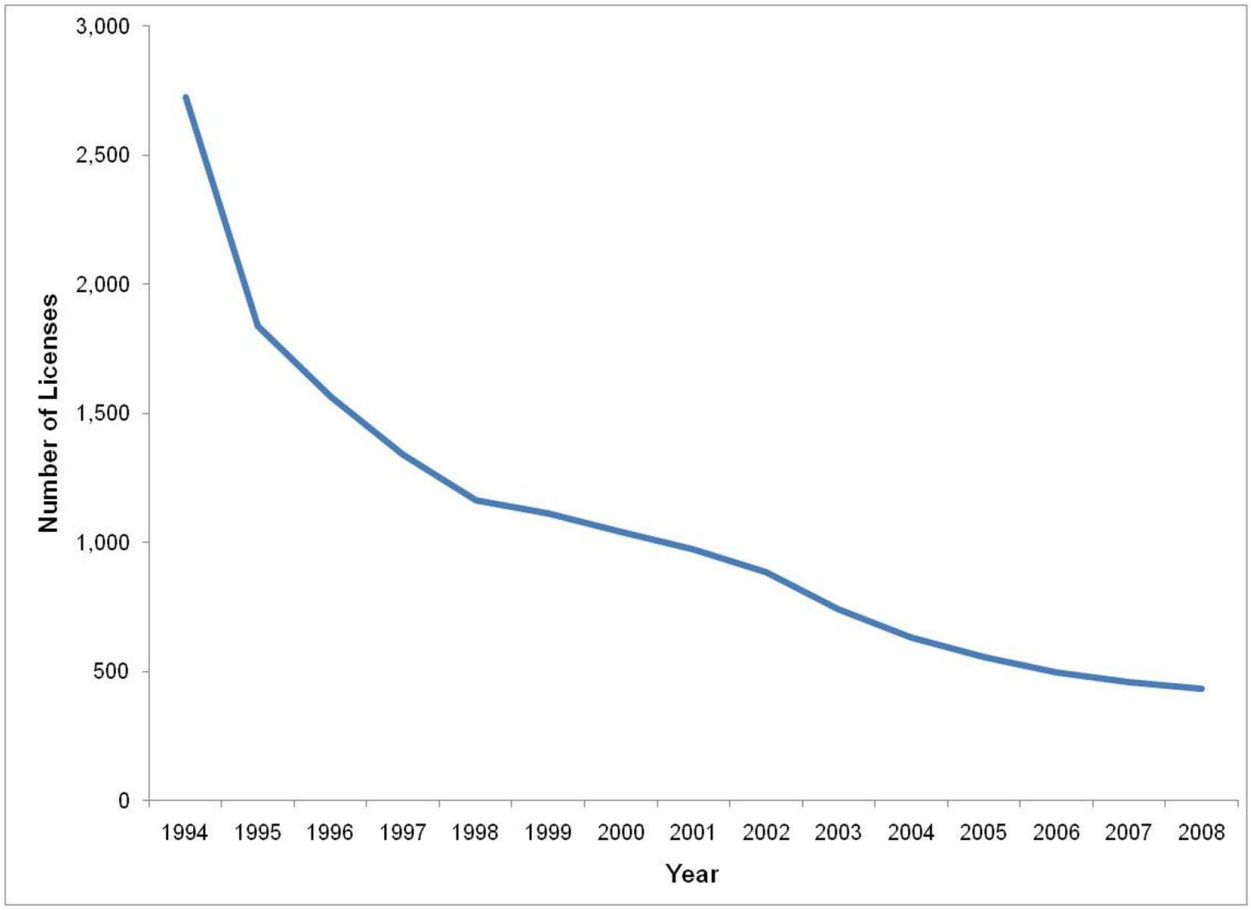


Figure 1.8 Number of sea urchin harvesting licenses in the state of Maine over time. Numbers of licenses has continually decreased since management began in 1994. (Data source: DMR).

Implications of Sea Urchin Management

The rehabilitation efforts of sea urchin management have seen limited success. The sea urchin management plan aims to increase sea urchin numbers with harvesting limits; however, current studies find that urchin numbers are bound-by ecological factors. Overfishing of urchins led to blooms in Irish moss and kelp beds (food for the urchins), with one DMR study concluding that seaweed beds increased from 71% in 2001 to 88% in 2003 (Clark 2008). The reestablishment of seaweed beds has increased shelter for rock crabs and green crabs, known predators of the sea urchins.

Sea scallops

Our second case study is the Gulf of Maine sea scallop fishery. The Gulf of Maine sea scallop fishery occurs primarily in Maine waters within three miles of shore (Hart 2008). Gulf of Maine scallop landings historically averaged about 500 thousand pounds of meat per year, peaking in 1980 with 3.2 million pounds (Figure 1.9). In the last eight years, landings have been low, averaging 203 thousand pounds per year.

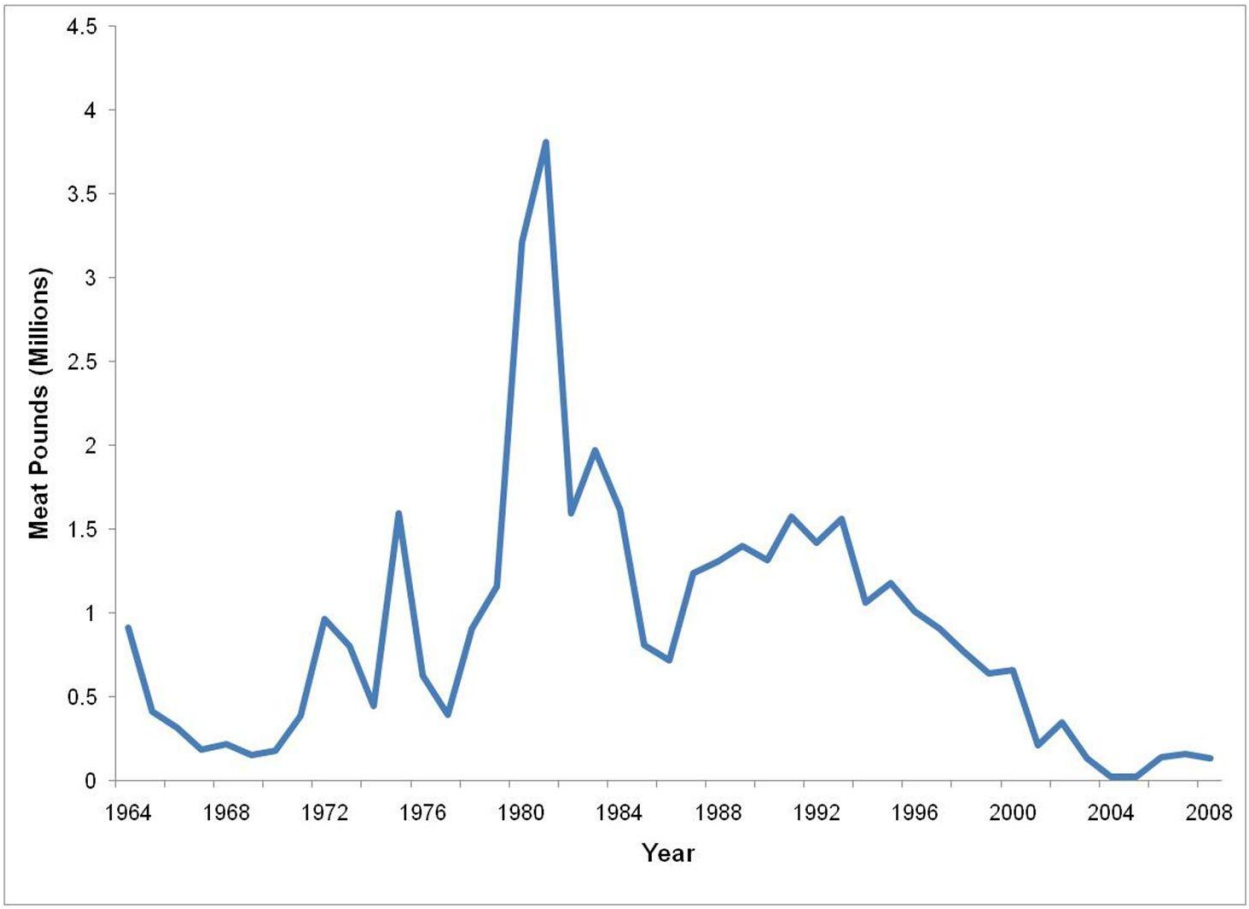


Figure 1.9 The amount of sea scallop harvest over time from 1964 to 2008. The harvest peaked in 1980 with 3.2 million pounds. (Data source: DMR).

In 2003, the Scallop Advisory Council was formed through Maine legislation (MRS Title 12, Chapter 623 §6729-B). The council consists of 13 members: four are scallop harvesters holding current hand fishing scallop licenses, four are scallop harvesters holding current draggers licenses, two are wholesale seafood license holders who deal in scallops, two are scientists with expertise in marine resources management, and one is a public member. Similar to the Sea Urchin Zone Council, the Scallop Advisory Council advises the Commissioner of DMR on issues related to seasons, closings, size

restrictions, and daily limits. In 2009-2010, the season will be 70 days and will begin December 15, 2009, and close March 24, 2010, with fishing prohibited on Sundays, Mondays, as well as the Fridays of December 25 and January 1. Additionally, there is a number of closure zones developed for the 2009-2010 season (Figure 1.11).

Implications of Sea Scallop Management

Similar to the survey study conducted for sea urchins, DMR completed a sea scallop survey to assess the state of the stock (Kelly 2009). Six different zones were surveyed. Results indicate that scallop numbers remain low and have declined in some areas. One region, between Penobscot Bay and western Blue Hill Bay, showed a slight improvement.

Atlantic Herring

The Atlantic herring fishery is our third and final case study. Atlantic herring is one of the most important fish in the Northeastern U.S for its role in the ecosystem and fishing industry (ASMFC Species Profile 2009). Herring are a highly valued bait fish for commercial fisheries including the lobster fishery. In the 1960s, the fishery was overexploited from foreign fishery development with a consequential fall in harvest in the 1970s (Figure 1.10).

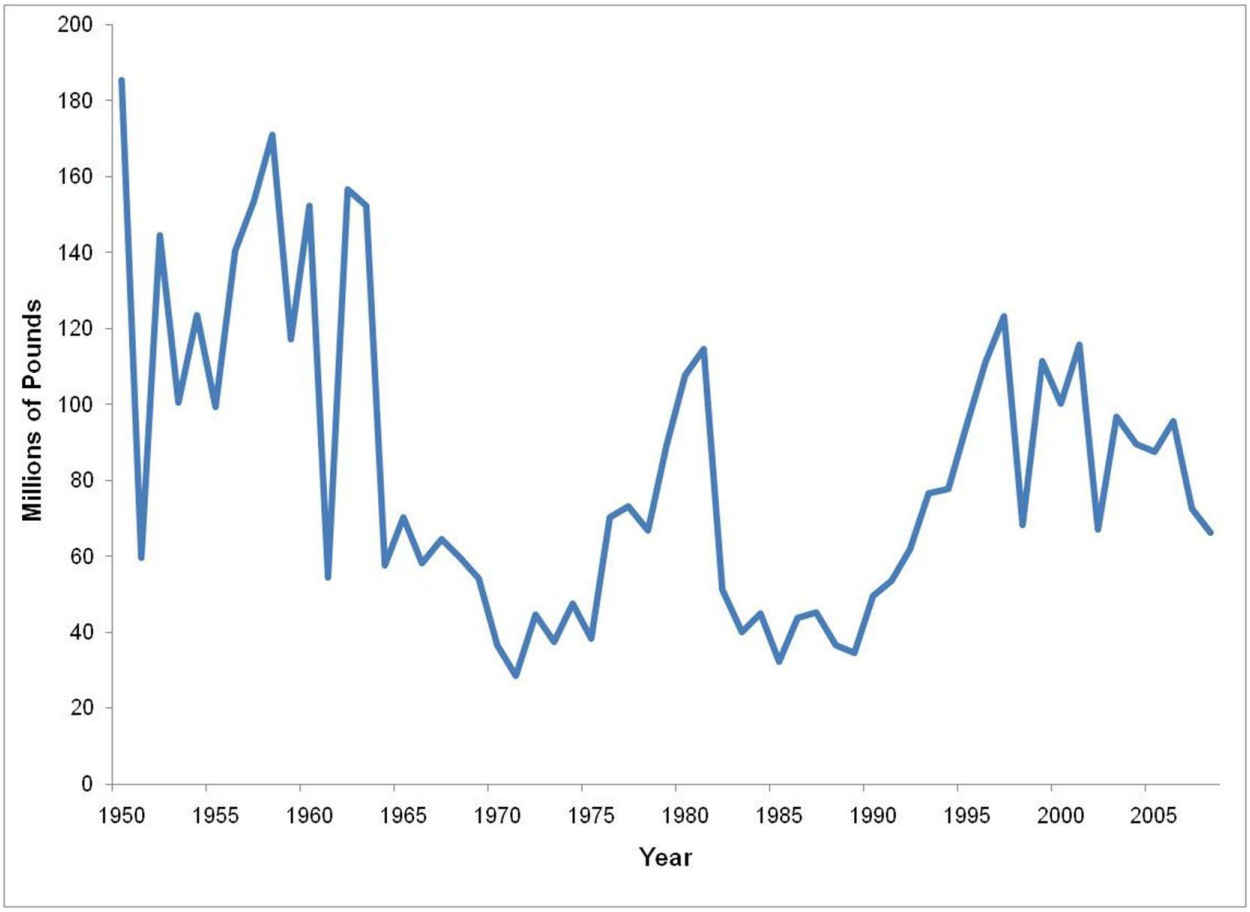


Figure 1.10 Maine's annual Atlantic herring harvest over time. The fishery was exploited in the 1960's with a subsequent fall in harvest in the 1970's. Successful management has brought herring harvest back up in recent years. (Data source: DMR).

The Atlantic Herring fishery is managed by both the Atlantic States Marine Fisheries Commission and the New England Fishery Management Council. The Commission regulates herring in state waters, whereas the Council regulates herring in federal waters. Management is characterized by four measures including spawning area closures, area management schemes (three areas), catch controls, and a Total Allowable Catch in the nearshore fishery (NOAA Fishwatch 2009). Maine falls within the Management Area 1 (subareas 1A and 1B) (refer to Figure 1.11). Management area boundaries are based on herring seasonal distribution and also the location of known spawning grounds.

The closure dates for Management Area 1 will be:

- Eastern Maine: August 15 – September 11
- Western Maine: September 1 – September 28

- Jeffreys Ledge/Stellwagen Bank: September 15 – October 12
- Cashes Ledge: August 1 – September 25

Atlantic herring is currently not exploited or overfished (NOAA Fishwatch 2009). The regional management plan, as well as the ecologically focused determination of closed areas, has allowed for the herring to reestablish itself. However, ASFMC and NEFMC feel the fishery could quickly become overexploited. They have initiated focus for future research on Atlantic herring habitat to better manage their closed areas. These research needs will include:

1. Identifying Atlantic herring spawning areas
2. Collecting data on species distribution and relative abundance in inshore waters (focus and attention have been in the offshore region)
3. Collecting information on how oceanographic factors (e.g. currents) affect distribution of herring
4. Determine the value of using protected areas to conserve and enhance herring stocks

(New England Fishery Management Council 2009)

The complex regulatory schemes we have investigated with our three case studies are further complicated by the remaining marine resource management plans found in Figure 1.11. As we have shown, management plans focus mostly on a single species for management. The Atlantic herring management plan has been the most successful of the three case studies. The Atlantic herring management plan incorporates spawning habitat locations into its designation of restricted access zones, integrating the ecology of the organism into its management plan. The relative failure of the sea urchin management plan is due in part to the plan's lack of ecological solutions (such as removing of kelp beds harboring crabs).

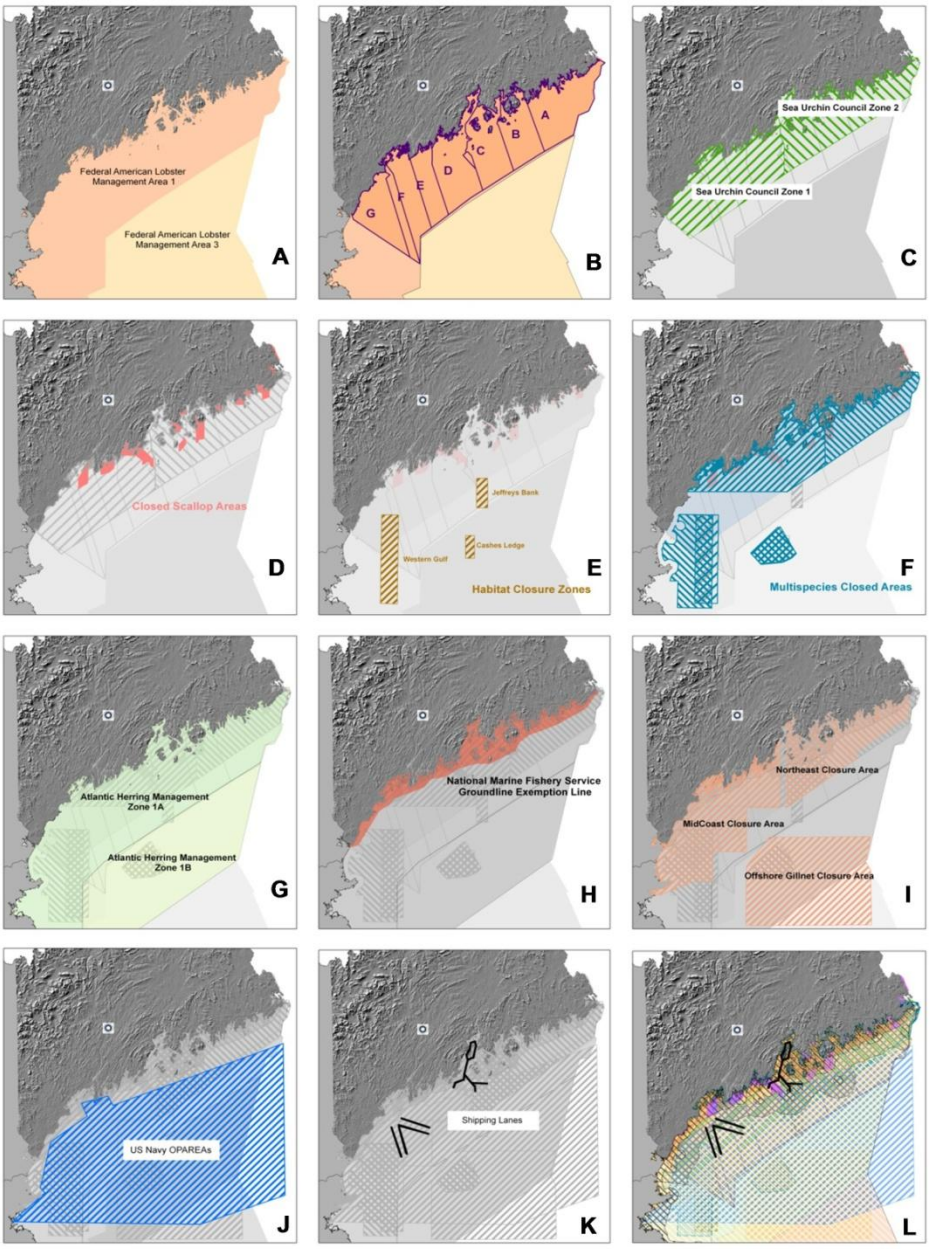


Figure 1.11 Management and use boundaries in the Gulf of Maine. As additional management boundaries are included, the overlap progresses. Map (A) includes the Atlantic States Marine Fisheries Commission's American lobster management areas; (B) Maine Lobster Advisory Council Management Zones; (C) Maine Sea Urchin Council Zones; (D) Maine Department of Marine Resources 3-year closed scallop areas; (E) NOAA Year Round Essential Fish Habitat Closure Zones; (F) NOAA Northeast Multispecies Groundfish Closed Areas; (G) New England Fishery Management Council Atlantic Herring Management Zones; (H) National Marine Fishery Service Groundline Exemption Line; (I) National Marine Fishery Service Gillnet Closure Areas; (J) U.S. Navy Operating Area; (K) Shipping Lanes; (L) all layers from maps A to K.

Spatial Analysis of Management and Use Boundaries

The number, location, and size of overlapping management zones in the Gulf of Maine are represented in Figure 1.12. We calculated that approximately 68% of the area within the three-mile state water boundary line holds 10 or more overlapping management zones. Seventy-nine percent of the area within the 200-mile EEZ holds between 6 and 12 overlapping management zones. The full range of spatial overlap values is represented in Table 1.3.

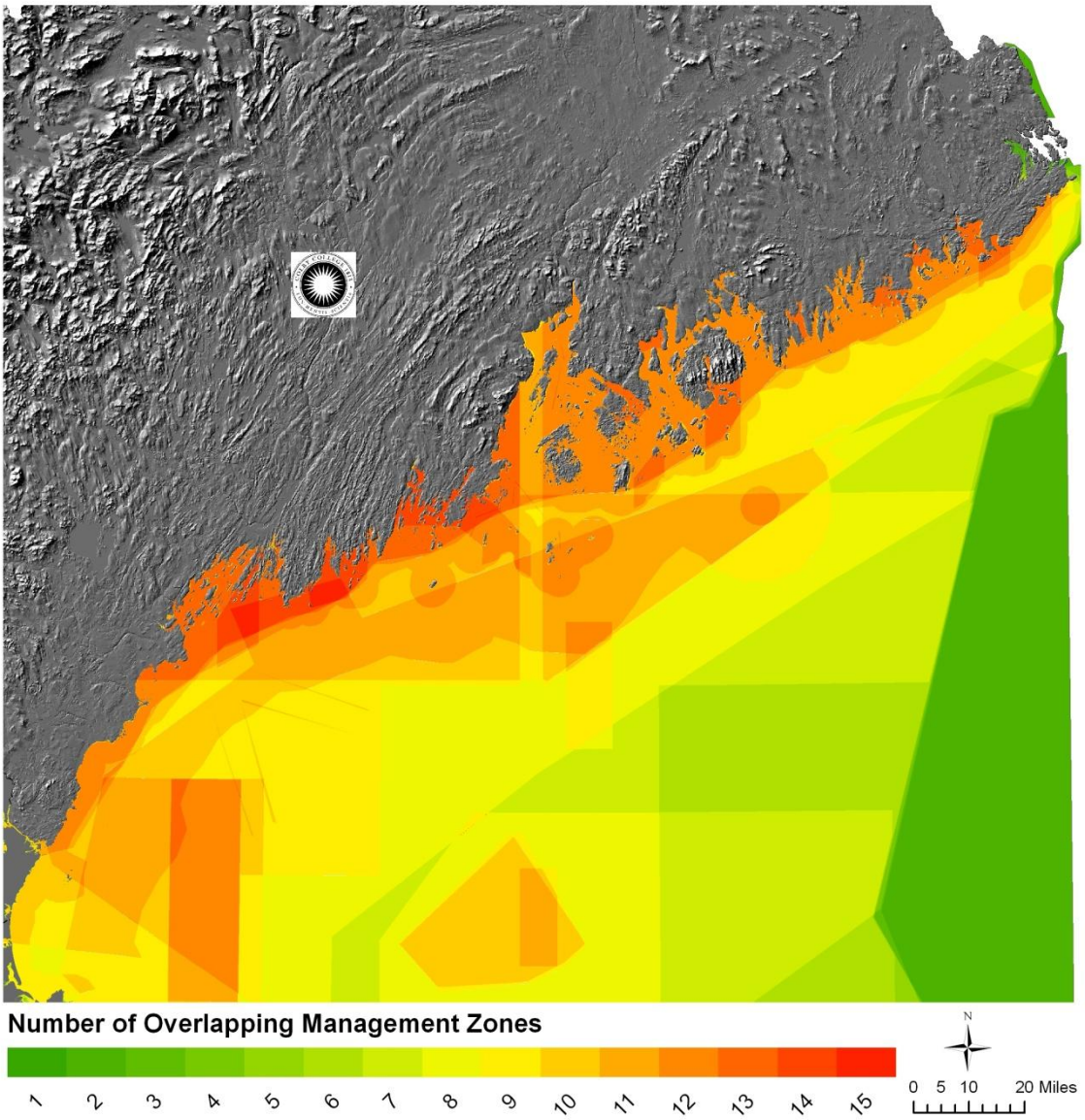


Figure 1.12 Density of jurisdictional and marine resource management zones off the coast of Maine. The Colby College seal represents the location

of Waterville, ME. The detailed coast runs from the NH border in the lower left to the Downeast Maine region in the upper right. Areas with a higher number of overlapping zones are represented by a hotter color. Sixty-eight percent of the area within the three-mile state water boundary line contains 10 or more overlapping management zones. Seventy-nine percent of the area within the 200-mile EEZ holds between 6 and 12 overlapping management zones.

Table 1.3 Spatial overlap analysis. The number of overlapping management zones in the Gulf of Maine by area (square miles) and percent of total area within Maine state waters and within the Exclusive Economic Zone (EEZ). Results based off of our GIS spatial overlap calculation in Figure 1.12.

Number of Zones with Overlap	Area (Square Miles) Within State Waters	Percent Total Area Within State Waters	Area (Square Miles) Within Federal EEZ	Percent Total Area Within Federal EEZ
1	0.0	0.0	1	0.0
2	1	0.0	2883	10
3	4	0.1	59	0.2
4	113	3	331	1
5	272	6	1913	7
6	175	4	4014	14
7	426	10	1627	17
8	189	4	4840	17
9	172	4	2574	9
10	389	9	2073	7
11	567	13	2005	7
12	1187	28	1640	6
13	493	12	527	2
14	185	4	184	0.7
15	48	1	47	0.2

Offshore Wind Energy

In this section, we evaluated the potential impact of the current regulatory system on the future development of offshore wind in the Gulf of Maine.

Legislative Mandate

In 2003, the Maine Wind Energy Act (MRS 35-A, section 3404(2)(B)) established state goals regarding wind energy. The Maine Wind Energy Act established policy that finds wind energy to be in the best interest of the state thereby making it a priority for state agencies to encourage wind development. It sets the goal to meet or exceed 2,000 megawatts of wind capacity by 2015 and least 3,000 megawatts by 2020. It also sets the goal to for offshore wind, which is 300 megawatts by 2020.

Offshore Wind Potential and Proposed Demonstration Sites

Maine has a large offshore wind potential. At a congressional hearing in July of 2008, University of Maine Professor Dr. Habib Dagher used the term "Saudi Arabia of Wind" to describe the Gulf of Maine's offshore wind energy potential. Maine's coastal waters are a vast resource (Figure 1.13), but Maine does not have a constructed offshore wind farms to harness this resource.

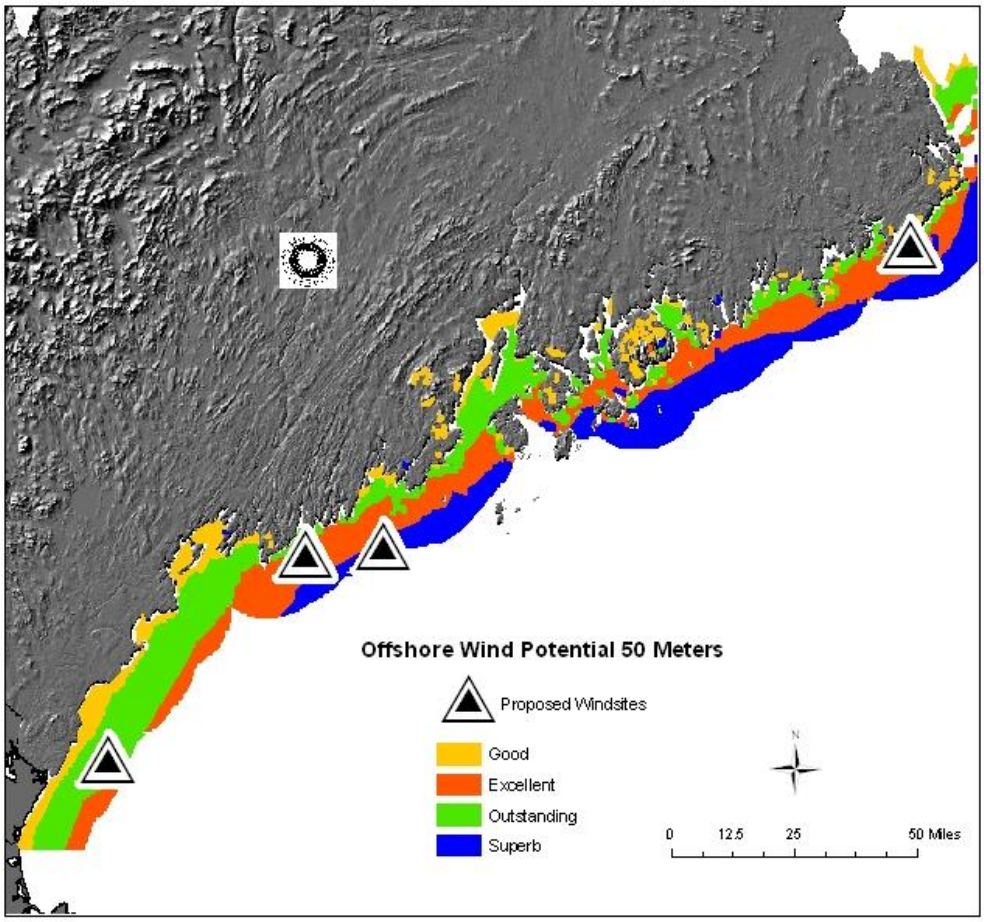


Figure 1.13 Representation of offshore wind potential at 50 meters above sea level. Maine's coastal waters are characterized by an offshore wind potential of Good to Superb. The triangle markers represent the sites for proposed pilot wind projects. (Data source: NREL)

Barriers to Offshore Wind Energy

There are obstacles preventing offshore wind farms from being economically viable. One of the biggest problems facing large-scale wind farms is that suitable sites are often far from urban centers (OCS 2009). Power is lost in transmission lines; transporting electricity far distances decreases the efficiency and benefits of wind farms. Other uncertainties to wind farms are unproven technology, costs, and possible environmental concerns. Wind technology has been established but not thoroughly tested. For example, even though wind turbines stop rotating at a predetermined speed to avoid spinning too quickly, there is still uncertainty regarding how the turbines will fare in storms and hurricanes. The cost of offshore wind farms in most

locations is not economically viable without government subsidies due to the high capital needs and the difficult permitting process (OETF 2009).

Since offshore wind technology and offshore wind farms are relatively new, their environmental impacts are not clear. Research has yet to be conducted on the effects on aquatic wildlife and flight patterns of birds over time. There is fear among fisherman that vibrations in the water around turbines will disrupt local fisheries (Ames 2009). Along with disrupting aquatic life, the vibrations could potentially cause seabed erosion. In addition, a real challenge for offshore wind farm development is that detailed benthic maps of the majority of Maine's coastal waters do not exist (OETF 2009). Detailed benthic maps would provide developers the ability to recognize suitable substrates for anchoring offshore wind platforms.

We show how additional problems occur for planners and developers of offshore wind with the number of overlapping management boundaries as shown in Figure 1.14. In order to gain the necessary permits, these developers need to get the approval of many agencies associated with the numerous overlapping management boundaries. Each agency has its own interests and mandates, therefore gaining approval can take several years (Lapointe 2009). Therefore, offshore wind farm siting is a contentious issue. There are many environmental, economic, and social concerns that are attached to an offshore wind farm. Lawsuits are a frequent occurrence in the development stages of a wind farm. Some stakeholders are afraid of the loss to the intrinsic value of the seascape from rotating turbines. As can be seen in Figure 1.14, if a wind farm were to be built in state waters, the project would fall into the jurisdictions of multiple different parties causing friction among the different agencies. Friction would occur because an offshore wind farm would affect stakeholders differently. Siting of an offshore wind farm must also take into account the effects on current shipping lanes. Additional challenges include Not-In-My-Back-Yard (NIMBY) opposition and law suits.

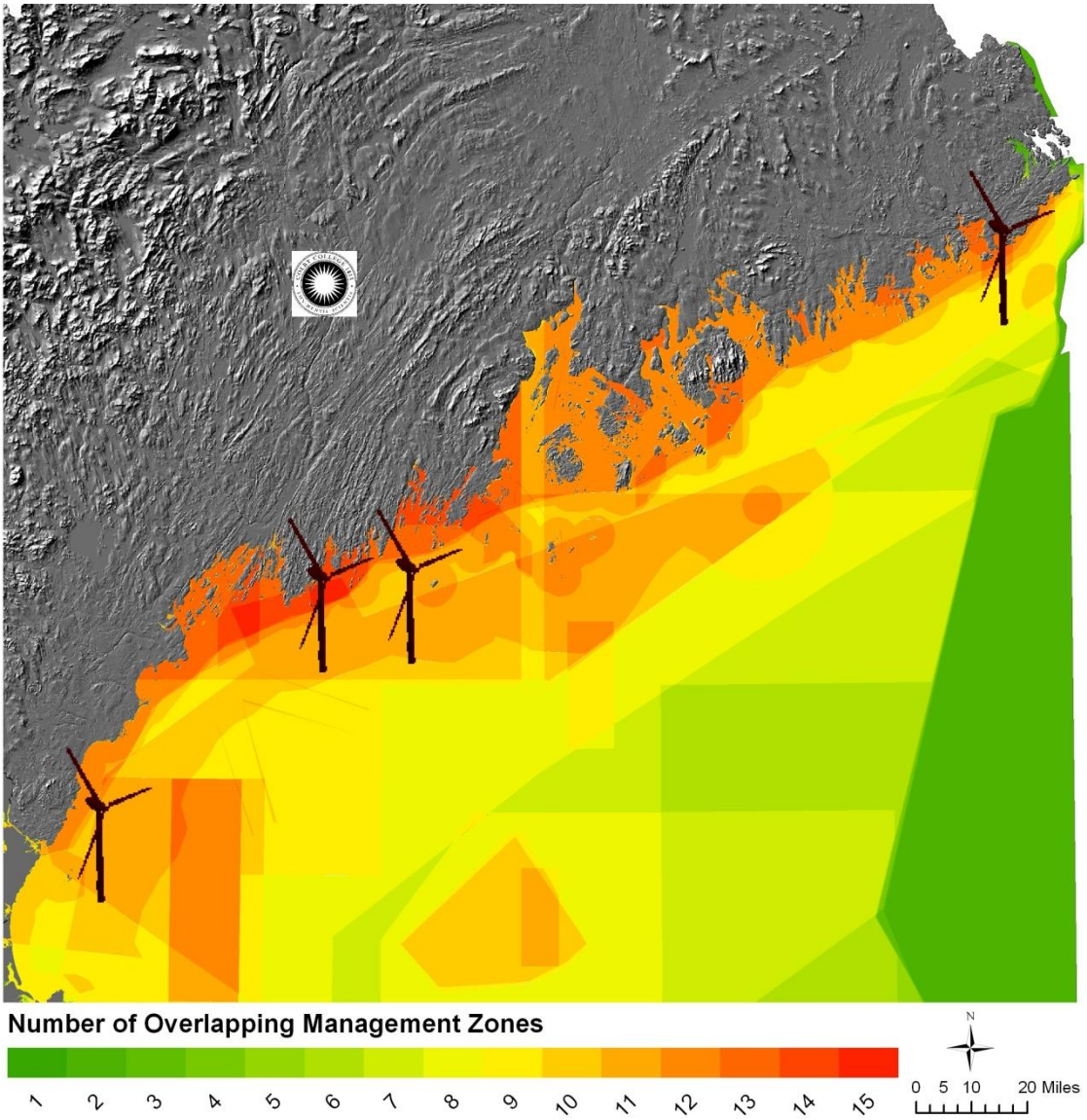


Figure 1.14 Density of jurisdictional and marine resource management zones off the coast of Maine. Areas with a higher number of overlapping zones are represented by a hotter color. Proposed demonstration sites for offshore wind platforms are represented by the windmill graphic.

Implications for Offshore Wind Energy

Even with the barriers we discussed above, there are a number of contributing factors that promise to aid in development of offshore wind energy resources. In November of 2008, Governor Baldacci established the Ocean Energy Task Force (OETF) by Executive Order (20 FY 08/09) and gave

the task force the objective of drafting recommendations that the state could follow to meet the goals of the Maine Wind Energy Act (SPO 2009).

Maine state legislature passed the OETF recommendation to streamline the offshore wind permitting process (MRS 270 L.D. 1465 (1)). In order to gain approval for the necessary permits, the streamline process requires reports be filed with the DMR that include field investigations, plans to deal with adverse effects of the turbines, and considerations for commercial fishing and other fish and wildlife as well as navigation plans. This is then subject to a 60-day review process. The developer must also consult with the DMR, the IWF, and the DOC; the Maine Land Use Regulation Commission, SPO; the U.S. Army Corps of Engineers, the U.S. Coast Guard, the National Marine Fisheries Service, the National Park Service and the FWS; the Lobster Management Policy Council and each municipality in proximity to the project. The permitting process takes time and money. Even with the "streamlined" permitting process, there are many challenges facing approval from the DOC, SPO, DMR, DEP, and the IWF.

In addition to the task force and legislative passage of the task force recommendations for streamlining the permitting process, Maine received $8 million of funding from the American Recovery and Reinvestment Act to test and develop offshore wind turbine platforms (The Free Press 2009). An additional $14 million in grants from federal, state, university, and private industries will follow the initial $8 million grant from the American Recovery and Reinvestment Act. As a result of these actions, four wind farms off the coast of Maine have been selected as proposed demonstration projects (Figure 1.13). The proposed demonstration sites are off of Boon Island, Damariscove Island, Monhegan Island, and Cutler. These offshore wind farms will test multiple 10kw turbines and one 100kw turbine. The state's end goal is to achieve 5 GW of electricity from offshore wind farms by 2030 (The Free Press 2009).

A National Ocean Policy

In addition to the complexity of coastal and marine resource management and its impact on development of important new and future technologies in the Gulf of Maine, there is a federal policy issue facing Maine. The federal government is currently re-evaluating its management of the ocean and its resources. Through a Memorandum to the Heads of Executive Departments and Agencies dated June 12, 2009, President Obama called upon an Interagency Ocean Policy Task Force to develop recommendations for a national ocean policy for the protection of our ocean, coastal, and Great Lake resources; the framework in which to make effective coordination of efforts; and an implementation plan (IOPTF, 2009). The Task Force is comprised of

24 senior policy-level officials from a range of executive departments, agencies, and offices across the federal government, and is chaired by the Chair of the Council on Environmental Quality. On September 10, 2009, the Task Force released an Interim Report, which was put up for public comment for 30 days. Maine has played an important role in the debate, with Senator Olympia Snowe co-chairing a Congressional hearing regarding the Task Force.

As a state that is heavily reliant on its coastal and marine resources, Maine will be directly affected by a new National Oceans Policy. We start by summarizing the recommendations of the Task Force, and continue by discussing the implications for Maine based on our analysis.

Policy Coordination Framework

The first goal of the National Ocean Policy will be to consolidate and strengthen the principal and deputy level components of ocean management within a single National Ocean Council (NOC) structure. A second goal is to strengthen the decision-making and dispute-resolution processes by defining clear roles for the NOC. The Task Force also recommends that a Governance Advisory Committee be created to formally engage with state, tribal, local, and regional governance structures. In addition, there will be a need to strengthen the link between science and management by creating an integrated Steering committee of the NOC. Lastly, the framework would work to strengthen coordination between the NOC, the National Security Council, the National Economic Council, the Office of Energy and Climate Change, the Council on Environmental Quality, the Office of Science and Technology Policy, the Office of Management and Budget, and other White House entities.

Although the policy coordination framework was created for the Federal government, a similar structure could be adopted at the state level. Citizens would then be able to learn the state and federal frameworks for ocean policy, alleviating some of the presently inherent confusion.

Through extensive reviews of current science and through a series of public hearings, the Task Force developed nine priority objectives:

1. Ecosystem-Based Management: Adopt ecosystem-based management as a foundational principle for the comprehensive management of the ocean and coasts.

2. Coastal and Marine Spatial Planning: Implement comprehensive, integrated, ecosystem-based coastal and marine spatial planning and management in the United States.

3. Inform Decisions and Improve Understanding: Increase knowledge to continually inform and improve management and policy decisions and the capacity to respond to change and challenges. Better educate through formal and informal programs the public about the ocean, coasts, and Great Lakes.

4. Coordinate and Support: Better coordinate and support Federal, State, tribal, local, and regional management of the ocean, coasts, and Great Lakes. Improve coordination and integration across the Federal Government, and as appropriate, engage with the international community.

5. Resiliency and Adaptation to Climate Change and Ocean Acidification: Strengthen resiliency of coastal communities and marine and Great Lakes environments and their abilities to adapt to climate change impacts and ocean acidification.

6. Regional Ecosystem Protection and Restoration: Establish and implement an integrated ecosystem protection and restoration strategy that is science-based and aligns conservation and restoration goals at the Federal, State, tribal, local, and regional levels.

7. Water Quality and Sustainable Practice on Land: Enhance water quality in the ocean, along our coasts, and in the Great Lakes by promoting and implementing sustainable practice on land.

8. Changing Conditions in the Arctic: Address environmental stewardship needs in the Arctic Ocean and adjacent coastal areas in the face of climate-induced and other environmental changes.

9. Ocean, Coastal, and Great Lakes Observations and infrastructure: Strengthen and integrate Federal and Non-Federal ocean observing systems, sensors, and data collection platforms into a national system and integrate that system into international observation efforts.

We feel the need to highlight that the National Ocean Policy calls for interaction of the federal government with states and regional organizations to perform ecosystem-based management plans. In this interaction, the states and regions will be called upon to locally implement the nine priority objectives. Maine has positioned itself well by having previously involved itself in regional management councils and committees, such as the Atlantic

States Marine Fisheries Commission and the New England Fishery Management Council. The state has also conducted two one year studies into management plans similar to those called for by the Task Force. These occurred at Taunton Bay and Muscongus Bay. A goal of the studies was to discover the needed resources to implement more diverse management plans statewide (Bay Management Group, Appendix N Selected Findings).

These two studies found that there is not enough ecological or social data to manage intelligently at a bay level. Also, local groups do not have the capacity to collect the needed information; state assistance is needed. The studies also found that GIS maps were "one of the most prized outcomes of the projects," yet consumed more time and more effort than any other component. State assistance is recommended for future studies. Both studies found that regular communication and coordination with the State was invaluable. Quoting the study, "People generally find state bureaucracy difficult tonavigate and appreciate having a point person to go to." The best work was done when it was part of a larger state initiative. The state might think to initiate a state policy framework in which these findings are incorporated.

Scenarios

In this section, we present three potential scenarios that Maine might move towards in the future of its coastal and marine management. These scenarios represent extreme outcomes; however, they are not unrealistic.

Confusion in Numbers: Status Quo

The "confusion in numbers" scenario, or the status quo scenario, would occur if Maine continued down the current track of managing with overlapping single-issue resource plans. As shown in this report, this management system is becoming increasingly difficult to manage because of the sheer number of overlapping zones and the number of agencies involved in managing coastal and marine resources. The process for new developments such as offshore wind has been slow and confusing.

If Maine were to continue with this system, additional overlapping management zones and regulating bodies would be sure to follow when a new issue emerges. An executive order, such as the one that established the Ocean Energy Task Force (OTEF) to "streamline" a process for offshore wind, would be common when it comes to successfully implementing new development.

Like Father, Like Son: Adopt National Ocean Policy

The "like father, like son" scenario would occur if Maine adopted a similar governance structure to the proposed National Ocean Policy by President Obama's Interagency Ocean Policy Task Force. The proposed National Ocean Policy will create a strong central authoritative body to oversee management of coastal and marine resources. The establishment of a strong central body will lessen the current level of competing regulatory bodies. If Maine were to establish a similar governance structure, confusion would be alleviated at the state level. The National Ocean Policy also calls for an ecosystem-based approach to management. Current single-species management programs would be managed together more effectively incorporating a broader range of ecological factors. Maine would need to increase its efforts in research and coordination in order to be successful in this scenario.

Tumbling Down: Top-down Management Approach

The "tumbling down" scenario would occur if Maine increased its top-down approach to management. This approach would limit public review and give more power to regulating agencies to make final decisions. Decisions regarding development of marine resources may be faster using this approach. However, top-down approaches have proved to be ineffective in the past. The sea urchin fishery is an example of top-down management in which the fishery collapsed.

Conclusion

Maine's coastal and ocean economies play a vital role in the health of Maine's economy and GDP. Management of these resources has been varied in strategy and success. It is important to note that many stakeholders have mandates that focus on a species-specific or issue-specific resource. The result is that many stakeholders conduct research and manage their respective interests independently of one another. However, we have shown in this report how these interests overlap in geographical space.

This administrative environment is not conducive to the development of important emerging technologies like offshore wind platforms. The complicated administrative environment requires the agreement of multiple agencies, interests, and mandates to approve new projects. The difficulties in constructing the demonstration projects have highlighted the need for a new approach to Maine's coastal and marine resource management. The National Ocean Policy Initiative working its way through Congress which

could address spatial overlap issues by having one overarching governing body.

Recommendations

The current management system is complicated and does not take into account the interconnected processes of an ecosystem. The top-down approach has proved to be ineffective in some management cases. Success has been shown through bottom-up approaches like the lobster fishery by active communication between fisherman and regulators. Therefore, we recommend that Maine incorporate a similar governing structure to our "like father, like son" scenario and adopt a model similar to the proposed the National Ocean Policy because it effectively integrates single-species management approaches into a larger ecosystem-based management. It balances efficiency with public and agency review. To incorporate the ecosystem-based management of that is inherent with this governing structure, the state should follow the suggestions of its two one-year studies that have expressed the need for state level support in training researches in GIS and data collection. Additionally, we recommend the state sponsor spatial analysis studies similar to what we have completed in this report to aid in their management of coastal and marine resources.

Works Cited

124th Maine State Legislature (2007). An Act to Facilitate Testing and Demonstration of Renewable Ocean Energy Technology.

Adams, P. (1986). The Cumulative impacts of Development in Southern Maine: Wetlands: Their Locations, Functions, and Value. M. S. P. Office*:* 28-36.

ASMFC (2009). "Atlantic States Marine Fisheries Commission." Retrieved November, 2009, from http://www.asmfc.org/.

Associated Press (2009). Offshore Wind Power Pilot Narrowed to 4. http://www.boston.com/news/local/maine/articles/2009/10/27/offshore_wind_power_pilot_narrowed_to_4/.

Carter, R.W.G. (1988). Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of the Coastlines, Academic Press, New York, 617 pp.

Casey, C., S. Chanin, et al. (2008). "State of Marine Fisheries in Maine 2008."

https://wiki.colby.edu/display/stateofmaine2008/State+of+Marine+Fisheries+in+Maine+2008.

Catena, J. G., S. Cole, et al. (1992). Policy Options for Maine's Marine Waters. M. C. P. Maine State Planning Office*:*47-57.

Courtney, F., Wiggin, J. "Ocean zoning for the Gulf of Maine: A Background Paper." Retrieved September, 2009, from http://www.mass.gov/czm/oceanzoningreport.pdf

Darling, B., E. Hansen, et al. (2007). "The State of Land Use, Planning, and Development in Maine." http://www.colby.edu/environ/courses/ES493/stateofmaine2007/papers/SOME07_Planning2.html

Dominie Consulting and Interagency Task Force on Invasive Aquatic Plants and Nuisance Species (2002). State of Maine Action for Managing Invasive Aquatic Species.

Energy Information Administration (2007). http://www.eia.doe.gov/cneaf/solar.renewables/page/state_profiles/maine.html

Food and Agriculture Organization (2009). "The State of the World Fisheries and Aquaculture 2008." Retrieved November, 2009, from http://www.greenfacts.org/en/fisheries/index.htm#il1

Gorman, M. (1993). Environmental Hazards: Marine Pollution, ABC-CLIO, Santa Barbara, CA, 252 pp.

Goulder, L. H. and Kennedy, D. (1997). "Valuing ecosystem services: philosophical bases and empirical methods." In Daily, G. (2007) In Nature's Services Societal Dependence on Natural Ecosystems, Islands Press, Washington, DC.

Gulf of Maine Area Census of Marine Life (2009). http://www.coml.org/projects/gulf-maine-program-goma.

Gulf of Maine Council on the Marine Environment (2009). http://www.gulfofmaine.org/.

Hinrichsen, D. (1998). Coastal Waters of the World: Trends, Threats, and

IPCC (2007). "Climate Change 2007: Synthesis Report." Retrieved November, 2009, from http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

Island Institute (2009). http://www.islandinstitute.org/.

Johnannesman, S. (2001). Final Report of the Committee to Study the Loss of Commercial Fishing Waterfront Access and other Economic Development Issues Affecting Commercial Fishing.

Klee, G.A. (1999). The Coastal Environment: Toward Integrated Coastal and Marine Sanctuary Management, Prentice-Hall, Inc., 281 pp.

Land and Water Resources Council (2001). Report on the Use of Incentives to Keep Land in Productive Farming, Fishing and Forestry Use. M. S. P. Office.

Land and Water Resources Council and Joint Standing Committee on Marine Resources (2002). A Review of the Effectiveness of the Maine Coastal Plan on Meeting the State's Public Access and Working Waterfront Policy Goals. M. S. P. Office.

Maine Department of Conservation (2009). http://www.maine.gov/doc/initiatives/oceanenergy/oceanenergy.shtml.

Maine Department of Economic and Community Development (2009). http://www.econdevmaine.com/.

Maine Department of Environmental Protection (2009).

Maine Department of Environmental Protection and Maine State Planning Office (1993). Review of Nonpoint Source Water Pollution Control Programs in Maine. Augusta.

Maine Department of Inland Fisheries and Wildlife (2009). http://www.maine.gov/ifw/.

Maine Department of Marine Resources (2009). George Lapointe.

Maine Department of Marine Resources (2009). http://www.maine.gov/dmr/index.htm.

Maine Department of Marine Resources (2009). Seth Barker.

Maine Department of Transportation (2009). http://www.maine.gov/mdot/.

Maine Office of GIS (2009). http://megis.maine.gov/catalog/catalog.asp?state=2&extent=cover.

Maine Sea Grant (2009). http://www.seagrant.umaine.edu/.

Maine State Planning Office (2007). 2006 Annual Report to Governor John Elias Baldacci and the Joint Standing Committee on Natural Resources of the 123 Third Maine Legislature. L. a. W. R. Council. Augusta.

Maine State Planning Office (2009). http://www.maine.gov/spo/.

Martínez, M.L., Intralawan, A., Vázquez, G., Pérez-Maqueo, O., Sutton, P., and Landgrave, R. (2007). "The coasts of our world: Ecological, economic and social importance." Ecological Economics **63**(2-3): 254-272

National Aeronautics and Space Administration (2006). Visible Earth: Earth's City Lights, http://visibleearth.nasa.gov/view_rec.php?id=1438.

National Ocean Economics Program (2009). NOEP Coastal Economies, http://www.oceaneconomics.org/Market/coastal/coastalEcon.asp.

National Ocean Economics Program (2009). Ocean Economies Data, http://www.oceaneconomics.org/Market/ocean/oceanEcon.asp.

National Ocean Economics Program (2009). State of the U.S. Ocean and Coastal Economies.

National Oceanic and Atmospheric Administration (2009). http://www.noaa.gov/about-noaa.html.

National Park Service (2009). http://www.nps.gov/acad/index.htm.

National Renewable Energy Laboratory Maine Wind Resource Map, http://www.windpoweringamerica.gov/maps_template.asp?stateab=me.

Nielsen, E.S. (1951). "Measurement of Production of Organic Matter in sea by means of Carbon-14." Nature 267: 684-685

NOAA (2009). "Oceans." Retrieved November, 2009, from http://www.noaa.gov/ocean.html

NOAA (2009b). "Marine Boundary Working Group." Retrieved November, 2009, from http://www.csc.noaa.gov/mbwg/htm/cad_sla.htm

Ocean Energy Task Force (2008). Report to the Governor's Task Force on Wind Power Development.

Ocean Energy Task Force (2009). Ocean Energy Task Force Interim Report.

OCS Alternative Energy and Alternate Use Programmatic EIS (2009). Offshore Wind Energy, http://ocsenergy.anl.gov/guide/wind/index.cfm.

Office of Revisor of Statutes (2007). http://www.maine.gov/portal/index.php.

Office of Sustainable Fisheries, NOAA Fisheries (2009). Retrieved November, 2009, from http://www.nmfs.noaa.gov/sfa/sfweb/

Penobscot Resource Center (2009). Ames, Ted.

Penobscot Resource Center (2009). Reed, Walter.

Pew Oceans Commission (2003). "America's Living Coast: Charting a Course for Sea Change." Retrieved November, 2009, from http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting_ocean_life/env_pew_oceans_final_report.pdf

Portman, M., J. Duff, et al. Offshore Wind Energy Development in the Exclusive Economic Zone: Legal and Policy Supports and Impediments in Germany and the US. Energy Policy. **37:** 3596-3607.

Roche, P., T. Manchanda, et al. (2008). "State of Private Land Conservation in Maine 2008."http://wiki.colby.edu/display/stateofmaine2008/State+of+Private+Land+Conservation+in+Maine+2008.

Senator Collins for U.S. Senator from Maine (2009). Energy Secretary to Discuss Funding for Maine Wind Research Center, http://senatorcollins.blogspot.com/2009/06/energy-secretary-to-discuss-funding.html.

Smith, V.H., Tilman, G.D., and Nekola, J.C. (1999). "Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems." Environmental Pollution 100(1-3): 179-196.

State Planning Office (2006). "Maine Coastal Program." Retrieved November, 2009, from

http://www.maine.gov/spo/coastal/downloads/coastalplans/McPlan_2006.pdf

State Planning Office (2006b). "Federal Consistency Review." Retrieved September, 2009, from http://www.maine.gov/spo/coastal/permitting.htm

State Planning Office and the Maine Department of Marine Resources (2007). "Managing Maine's Nearshore Coastal Resources." Retrieved October, 2009, from http://www.maine.gov/spo/legandgovreports/docs/2007managingnearshoreresources.pdf

Strategies, Washington D.C. Island Press.

The Free Press (2009). Maine Gets $8 million to Develop and Test Floating Offshore Wind Turbine Platforms. The investment will help create the first floating deepwater offshore wind program in the country.

The Gulf of Maine Research Institute (2009). http://www.gmri.org/.

Turnipseed, M., Crowder, L.B., Sagarin, R.D., Roady, S.E. (2009). "Legal Bedrock for Rebuilding America's Ocean Ecosystems." Science **324**(5924): 183-184.

U. S. Fish and Wildlife Service. (2009). "Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service: Coastal Zone Management Act of 1972." Retrieved September 23, 2009, from www.fws.gov/laws/lawsdigest/COASZON.html.

U.S. Department of Energy (2009). Maine Ocean Energy Task Force.

U.S. Energy Department (2009). http://www.windpoweringamerica.gov/pdfs/wind_maps/me_50m.com.

U.S. Environmental Protection Agency (2009). http://www.epa.gov/.

U.S. Fish and Wildlife Service (2009).http://www.fws.gov/.

U.S. Geological Survey (2009). http://www.usgs.gov/.

U.S.C. 12 §§ 4601-4656 (1942). Atlantic States Marine Fisheries Compact

U.S.C. 16 §§ 1451-1456 (1972). Coastal Zone Management Act

U.S.C. 16 §§ 1801-1882 (1996). The Sustainable Fisheries Act

U.S.C. 16 §§ 1801-1884 (1976). Fishery Conservation and Management Act – Magnuson-Stevens Act

U.S.C. 16 §§ 5101-5108 (1993). Atlantic Coastal Fisheries Cooperative Management Act

U.S.C. 43 §§ 1301-1315 (1953). The Submerged Lands Act

UNEP (2007). "National Marine Debris Monitoring Program." Retrieved November 2009, from http://www.unep.org/regionalseas/marinelitter/publications/docs/NMDMP_REPORT_Ocean_Conservancy__2_.pdf

United Nations (1982). "United Nations Convention on the law of the sea." Retrieved September, 2009, from http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm

United Nations (2009). "Territorial Sea and Contiguous Zone" Retrieved November, 2009, from http://www.un.org/Depts/los/convention_agreements/texts/unclos/part2.htm

United Nations (2009). Chronological lists of ratifications of, accessions and successions to the Convention and the related Agreements as of 06 November 2009http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm#The%20United%20Nations%20Convention%20on%20the%20Law%20of%20the%20Sea

University of Maine and Maine Shore Stewards (2009). http://www.umext.maine.edu/shorestewards/Default.htm.

USGS (2009). "The Water Cycle." Retrieved November, 2009, from http://ga.water.usgs.gov/edu/watercycle.html

van der Meulen, F., Bakker, T.W.M., Houston, J.A. (2004). "The costs of our coasts: examples of dynamic dune management from Western Europe." p 259-178 In: Martinez, M.L., and Psuty, N. (2004), Coastal Dunes: Ecology and Conservation_,_ Springer-Verlag, Berlin.

State of Rivers and Dams in Maine

By Samuel Brakeley and Zachary Ezor

Executive Summary

The *State of Rivers and Dams in Maine* is the second chapter in *The State of Maine's Environment 2009*, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report published since 2004.

The 31,752 miles of rivers and streams in Maine are important to Maine's economy, ecological health, and cultural heritage. Dams have shaped both the natural flows and the societal uses of rivers in Maine for over two centuries. Although no new dams have been built since 1986, remaining dams continue to have environmental and economic impacts. In this chapter we discuss the state of rivers and dams in Maine, focusing on the history of dams, their current status, and the growing trend of dam removal. We give particular attention to diadromous – or migratory – fish and how dams and dam removals affect their traditional migration routes. We conducted an extensive literature review and performed original analysis using Geographic Information Systems. This chapter shows that Maine's surface water quality is commendable, ranking number one in the U.S. We illustrate the growth of the number of dams in Maine over time, and investigate a boom in dam construction between 1875 and 1900. We also examine dam removal, a contentious topic, in light of the federal and state regulatory processes and the environmental benefits and drawbacks of dams. Finally, we analyze the historical habitat of 12 species of diadromous fish and find that 65% of dams that have been removed in Maine, or are slated for removal in the near future, intersect the habitats of six or more species while less than 1% of dams still standing intersect the habitats of six or more species . We conclude that while Maine's river health is in excellent condition, more can be done to allow diadromous fish populations renewed access to their historical habitat and spawning grounds. Although fish bypasses are feasible, only a small percentage of migrating fish find the necessary entrance. Dam removal is an increasing trend and should be considered as a viable option to restore diadromous fish habitat and spawning grounds. We offer several recommendations to increase river health and productivity, including the continued monitoring of river and stream health, a state-wide prioritization of dams to consider for fish bypass installation, and an increased emphasis on dam removal as a method for river restoration and public safety.

Introduction

Rivers and streams played an integral part in Maine's history. Native Americans have always used the waterways for food, water, navigation, and cultural and spiritual sustenance. In 1607, the first settlers built a town along the Kennebec River, eventually following the rivers inland to build new settlements (Foran 2002). Lumberjacks used the rivers to float timber to downstream mills in the famous log drives, peaking in 1890 with 894 sawmills which employed 1,540 lumberjacks and sawhands (Defebaugh 1907). Later, as populations grew, rivers were employed as a source of power for emerging mills. In the early 1880s the turbine was developed, leading to an explosion in hydropower generation in the U.S. By 1940, 40% of electrical generation in the U.S. was generated by hydropower (U.S. Department of Energy 2008). Currently, hydropower accounts for about 30% of Maine power generation and 10% of U.S. power generation (Wisconsin Valley Improvement Company ; State of Maine Public Utilities Commission 2009). Although rivers and streams are important, they have also been used as refuse dumps for as long as humans have populated their shores. In 1899, the Rivers and Harbors Act was passed in recognition that this practice not only impeded navigation but also posed significant threats to river ecosystems. Since rivers appear to remove all debris, they are often degraded over time, and Maine is still facing the repercussions of some of these past poor practices.

Dams have been constructed since the first settlers arrived in Maine, creating reservoirs for navigational aid, flood control, drinking water, recreational use and later, hydropower generation. By 1986, a total of 782 dams had been built (GIS Data Catalog - Maine Office of GIS 1987). They have significant helped to harness the river's power and wealth, as well as increase safety along rivers from seasonal floods. However, dams also interrupt the natural flow of a river, and can cause ecological harm through sedimentation, erosion, and pollution. They can also inhibit fish migrations. Fish bypass systems have been constructed alongside some dams for as long as dams have been built, but they are never 100% effective, and for some species such as the Atlantic sturgeon, they are useless since sturgeon have never been shown to successfully use a bypass (American Rivers 2002). Since the mid 1980s administrators, government agencies, and environmental groups have begun to advocate for dam removal (Becker 2009). In 1986, the Milton Leatherboard Lower Dam became the first dam in Maine to be removed through a joint effort with the New Hampshire Department of Environmental Services, and since then 16 additional dams have been removed, with more proposed or under study (Murch 2009). Dam removal remains a controversial process, however, and other factors should also be considered when attempting to improve river health.

Focus of this Chapter

In this chapter we provide an overview of the state of river and stream health in Maine, and compare Maine to other states. We describe the historical trends of dam construction in Maine, examine why these trends occurred, and discuss recent dam removal cases. We examine the effect that dams have on river ecosystems, specifically diadromous fish (fish that spend part of their lives in freshwater and part in salt water) and their habitats. We assess the effectiveness of fish bypass systems in Maine. Finally, we describe three scenarios of what the future of river health, dams, dam removal, and fish bypass systems might look like, examining the possibility and potential repercussions of each trend on Maine's environment. We conclude by summarizing our key findings and offering some suggestions for moving forward on dam policy and ensuring that Maine continues its record of excellent river health.

Methods

We assembled background historical information by surveying and reviewing existing literature and commentary on rivers and dams in the U.S. Federal reports, issued by the Army Corps of Engineers (Corps), the Federal Energy Regulatory Commission (FERC), and the Environmental Protection Agency (EPA) were used to obtain national data on both rivers and dams. The Maine Department of Environmental Protection (DEP), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), and the nonprofit groups Natural Resource Council of Maine (NRCM) and Maine Rivers provided explanations of federal and state laws, and of the regulatory process for constructing, altering, and removing dams in Maine. This information was supplemented by email correspondence with representatives from the Atlantic Salmon Federation (ASF), Florida Power and Light Company (FPL), and the Maine Department of Marine Resources (DMR).

We obtained spatial data from the Maine Office of GIS for impounds and historic and current diadromous fish habitats (GIS Data Catalog - Maine Office of GIS 1987). The impounds data contained construction dates, primary usage, locations, and sizes for all dams in Maine. The fish habitat data spatially depicted habitat for 12 species of migratory fish.

We used the Geographic Information System (GIS) software program ArcGIS 9.3 (ESRI 2009) to visually represent and to analyze spatial data. We grouped dams by age and displayed the growth of dams in Maine over time. We developed a simple method to determine which impoundments intersected migratory fish habitat. We placed a 50 meter spatial buffer on

each river that had one of the twelve fish species inhabiting it. We selected all the dams that intersected each buffer. Dams that intersected a species' habitat received a value of (1) while dams that did not intersect habitat retained a (0) value. By totaling these values we were able to rank dams based on the number of species' habitats each dam intersected throughout the state.

Several attributes of the data affected our analysis. Because the impounds data were represented as simple centroids, the locations of some impoundments were slightly skewed. Our source at the Maine Office of GIS claims a high degree of certainty for these data, but does not rule out possible inconsistencies (Houston 2009).

Laws and Institutions

Maine's rivers are protected by several federal and state laws. These laws govern activities along the rivers, set standards for water quality and ecosystem health, and regulate sources of pollution. The following sections detail some of these important laws and institutions. Special attention is given to the laws and agencies responsible for overseeing the construction and removal of dams.

Federal Laws

The Rivers and Harbors Act is generally considered to be the first federal environmental law, but it dealt primarily with navigation. The Environmental Protection Agency (EPA) was created in 1970, which has greatly aided the U.S. in comprehensive environmental protection and better management practices. Several laws addressed water protection in the 1950s and 1960s but it was not until 1972 that the U.S. passed comprehensive legislation dealing with water quality: the Clean Water Act. Table 2.1 below provides a short summary of federal laws affecting rivers and dams.

Table 2.1 Federal laws, years, and descriptions pertaining to rivers and dams

Law	Year	Description	Location
Rivers and Harbors Act	1899	Requires a permit for altering navigable waters, and forbids the discharge of refuse matter into navigable waters. Overseen by the Army Corps of Engineers.	USC Title 33 § 403
Federal Water Power Act	1920	Created the Federal Power Commission to coordinate federal hydroelectric projects under	USC Title 16 § 791-828c

		federal control. In 1977 it was reorganized as the Federal Energy Regulatory Commission (FERC) with expanded responsibilities.	
National Historic Preservation Act	1966	Created a national inventory of all districts, sites, buildings, structures, and objects worthy of preservation, and requires a review process of any project that will affect listed sites. Overseen by the Advisory Council on Historic Preservation, the National Park Service (NPS) and State Historic Preservation Officers (SHPOs).	USC Title 16 § 470
National Environmental Policy Act	1970	Requires all agencies to consider environmental impacts of potential projects by preparing an Environmental Impact Statement (EIS) for all projects. Overseen by the Environment Protection Agency (EPA).	USC Title 42 § 4321
Clean Water Act (CWA)	1972	Amended the Federal Water Pollution Control Act of 1948 and created national water quality standards and a National Pollutant Discharge Elimination System (NPDES) permitting scheme for polluters to regulate the amount of pollution emitted. Overseen by the EPA.	USC Title 33 § 1251-1376
Endangered Species Act	1973	Lists nationally endangered species and provides for protection and recovery of species. Encourages the formulation of state endangered species programs. Overseen by the EPA.	USC Title 16 § 1531-1544
Magnuson-Stevens Act	1976	Requires establishment of regional fishery management plans to prevent overfishing and exploitation of resource. Overseen by the National Oceanic and Atmosphere Administration	USC Title 16 § 1801-1882

(NOAA).

Rivers and Harbors Act (1899)

The Rivers and Harbors Act was originally intended to prevent the dumping of garbage and refuse into New York harbor. The law also includes provisions prohibiting the construction of any bridge, dam, dike, or causeway over or in navigable waterways without the Army Corps of Engineers' (Corps) approval. The building of wharfs, piers, jetties, or other structures into navigable waterways is also prohibited without approval from the Corps, and any excavation, dredging, or fill required for projects in navigable waters requires approval as well (U.S. Fish and Wildlife Service 2009c).

Federal Water Power Act (1920)

The Federal Water Power Act and its later amendments created the Federal Power Commission (FPC), now known as the Federal Energy Regulatory Commission (FERC), to oversee the licensing and re-licensing of hydropower projects. FERC is authorized to issue licenses to construct, maintain, and operate any dams, water conduits, reservoirs and transmission lines that are in, on, or affecting navigable waters. In deciding whether to issue or renew a license, FERC is required to give 'equal consideration' to power and development; energy conservation; protection, mitigation of, damage to, and enhancement of fish and wildlife; protection of recreational opportunities, and preservation of other aspects of environmental quality (U.S. Fish and Wildlife Service 2009d). Licenses may not exceed fifty years, and FERC must consider recommendations from various bodies and agencies, including any affected Indian tribes (USC Title 33 § 518. 2002). FERC is required to mandate the construction, maintenance, and operation of fish passage facilities such as fish ladders or elevators if necessary to the continued preservation of the fisheries (U.S. Fish and Wildlife Service 2009d). In 1994 FERC concluded that it has the authority to refuse to relicense a dam, as well as the authority to order the removal of a dam if necessary for the continued maintenance of fisheries, recreation, wildlife, and other factors. This authority has been used once, and resulted in the removal of the Edwards Dam in Maine (see Case Study 2.2 below) (Natural Resources Council of Maine 2009).

National Historic Preservation Act (1966)

The National Historic Preservation Act created the National Register of Historic Places, a list of historically significant sites, buildings, districts, structures, and objects to the United States. The Advisory Council on Historic Preservation and the National Park Service oversee the program

while states appoint State Historic Preservation Officers (SHPOs) to create a statewide preservation program, standards for applying to the register historic sites, and plans to ensure the continued integrity of historic places. Any dam or waterway construction that may impact an historic place requires the proper permitting from the SHPOs for it to begin. Additionally, dams themselves may become historic places and therefore any plans for maintenance, upkeep, or removal also need to consult the SHPO before undertaking any projects (Advisory Council on Historic Preservation 2002).

National Environmental Policy Act (1970)

NEPA requires the preparation of an environmental impact statement (EIS) for any federal project which may impact the environment. It must include the environmental impact of the proposed action; any adverse environmental effects which cannot be avoided should the proposal be implemented; alternatives to the proposed action; the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented (USC Title 42 1969).

All relevant agencies must be consulted when preparing the EIS and it must be made public with a suitable time period for comment. The EIS has become the most influential part of NEPA, and its effects have been wide-ranging on a number of proposed projects (USC Title 42 1969).

Clean Water Act (1972)

The Clean Water Act (CWA) issued broad objectives to restore and maintain the nation's navigable waters, requiring water quality standards to be set as well as point and non-point sources of pollution to be addressed. It also created the National Pollutant Discharge Elimination System (NPDES) which authorized the EPA to issue discharge permits to polluters, and to limit pollution on an industry-wide basis. The CWA was the first federal law that comprehensively addressed water quality. The newly created Environmental Protection Agency (1970) was mandated with its enforcement (U.S. Fish and Wildlife Service 2009a).

CWA also specifically addressed dams. FERC is required to consider the biological and environmental effects of a hydroelectric project before issuing a license to a proposed hydroelectric dam. If certain considerations are not met, then FERC cannot issue a license. Additionally, the EPA is required to monitor the water quality effects attributable to the stillwater (the reservoir created behind the dam as a result of construction) (EPA 2009).

Finally, CWA states that Native American tribes are to be treated as states and therefore have a right to be included in all discussions pertaining to water rights and pollution on rivers and streams on Native American lands. This is important to Maine since there are several tribes throughout the state. See Case Study 2.1 for a description of the Penobscot River Restoration Project, which included the Penobscot Indian Tribe in the agreement (USC Title 33 § 518. 2002).

Endangered Species Act (1973)

The Endangered Species Act (ESA) authorizes the determination and listing of species as endangered and threatened; prohibits unauthorized taking, possession, sale, or transport of endangered species; provides authority to acquire land for the conservation of listed species, using land and water conservation funds; authorizes establishment of cooperative agreements and grants-in-aid to states that establish and maintain active and adequate programs for endangered and threatened wildlife and plants (U.S. Fish and Wildlife Service 2009b).

States are required to create and implement recovery plans for endangered species within their borders. All federal agencies must ensure that proposed projects do not endanger either endangered species or their critical habitats. Recovery plans must be created and implemented to ensure the long-term maintenance and recovery of endangered populations. Environmental groups have used the ESA to halt many federal projects, such as dam construction, to protect fragile land and water habitat for endangered species (NOAA 2009b; U.S. Fish and Wildlife Service 2009b).

Magnuson-Stevens Act (1976)

The Magnuson-Stevens Act creates an exclusive economic zone (EEZ), stretching 200 miles off the U.S. coast, which gives the U.S. authority over all actions that occur within the EEZ. The U.S. imposes regulations on permitting, importation, and fishery management. NOAA is given federal authority to oversee fishery management, and the act creates eight regional fishery management councils that are mandated to establish fishery management plans (FMPs) for each region. Since diadromous fish migrate up rivers periodically, the Magnuson-Stevens Act also affects any section of river that includes diadromous fish habitat. Any proposed project on these river sections needs to be done within the bounds of the FMP, and permitting may be required if the diadromous fish are adversely affected (NOAA 1996).

American Recovery and Reinvestment Act (2009)

The American Recovery and Reinvestment Act of 2009 provides various tax incentives and stimulus funds for many aspects of the U.S. economy and infrastructure. In regards to river health and dams, energy companies can take advantage of these funds to upgrade existing infrastructure and power generation equipment. This can allow improved efficiency of dams' power generation capabilities (USC Title 26 § 1101-1112 2009).

State Laws

Maine state law acts to protect rivers and streams so that they meet or exceed federal standards for water quality and species protection. Since the 1950s various incarnations of a Water Classification Program have categorized Maine rivers based on goals for water quality. The Maine Natural Resources Protection Act regulates all construction activity near rivers, streams and brooks, and the Maine Endangered Species Act allows the government to protect the habitat of threatened and endangered species---even if they don't appear on the national registrar. The Maine Waterway Development and Conservation Act governs the building, altering, or removal of hydropower dams by requiring state permits for these activities. Finally, two important laws, the Maine Natural Resources Protection Act and the Non-Point Source Pollution Program, regulate non-traditional sources of pollution and disturbance that may affect river health.

Table 2.2 State laws, years, and descriptions pertaining to rivers and dams

Law	Year	Description	Location
Water Classification Program	1950	Classifies Maine's surface waters, establishes water quality goals, and directs the state to meet these goals.	MRS Title 38 § 464-470
Land Use Regulation Law	1971	Creates the Land Use Regulatory Commission (LURC) and identifies its mission. LURC is tasked with permitting dams in the unorganized territory.	MRS Title 12 § 683-685
Maine Endangered Species Act	1975	Authorizes the Department of Inland Fisheries and Wildlife (IF&W) to identify	MRS Title 12 § 7751-7759

		species that should be listed as either threatened or endangered. IF&W also establishes protection guidelines for the species and their "essential habitat."	
Maine Waterway Development and Conservation Act	1983	Mandates that a permit be issued for the construction, reconstruction, alteration or removal of hydropower projects.	MRS Title 38 § 630-640
Maine Rivers Policy	1983	Declares general policy guidelines for managing Maine's rivers.	MRS Title 12 § 401-406
Maine Natural Resources Protection Act	1987	Requires that a permit be obtained for dredging or construction projects near rivers, streams and brooks.	MRS Title 38 § 480-A to Z
Non-Point Source Pollution Program	1991	Enacted to combat Non-Point Source Pollution (NPS). Implements the Maine Department of Environmental Protection's "best management practice" guidelines for such sources.	MRS Title 38 § 410-H

Water Classification Program (1950)

Maine values its surface waters. Water classification programs were established in the 1950's in concordance with the long-term goal of achieving the best possible water quality standards. The current water classification system establishes water quality goals for the State and is used to advise agencies and policy makers on protecting and managing surface waters. The classification standards designate uses, related characteristics of those uses, and the criteria necessary to protect those uses. Once

classified, a water body is protected by the anti-degradation provisions of the water quality statute (MDEP 2005c).

Water Quality Classifications

Maine currently has eight classifications for surface waters: four classes for freshwater rivers, three classes for marine and estuarine waters, and one class for lakes and ponds. The classes, which range from AA to D, may be understood as a hierarchy of risk (MDEP 2005c). Water-based ecosystems with higher class ratings are considered to be less susceptible to disturbance - man-made or natural - and recover rapidly when disrupted. Conversely, ecosystems with lower classifications are considered to be more vulnerable, with a high risk of degradation. All of these classifications meet the CWA's fishable-swimmable criterion, which mandates that all rivers be suitable for human recreation unless the EPA determines that these standards are impossible to meet (MDEP 2005c). The designated uses vary only slightly from class to class.

Table 2.3 Standards for classification of rivers in Maine

Class	Criteria	% Maine Rivers and Streams (2006)
AA	• Applied to "outstanding natural resources," which should be preserved for their unique ecological, social, scenic, or recreational importance. • No direct discharge of pollutants allowed if reasonable alternatives exist without approval from the MDEP. • Aquatic life, dissolved oxygen and bacteria content are as naturally occurs.	7%
A	• Direct discharges are only allowed if the discharged effluent is of equal or better quality than the existing water quality of the receiving rivers. • Aquatic life and bacteria content are as naturally occurs. The dissolved oxygen content may not be less than 7 parts per million or 75% of saturation, and must be higher during fish spawning.	46%
B	• Habitat must be clarified as unimpaired. • The dissolved oxygen content may not be less than 7 parts per million or 75% of saturation, and must be higher during fish spawning.	46%

	• Discharges may not cause adverse impact to aquatic life.	
C	• Discharges may cause some changes to aquatic life, but must be of sufficient quality to support and maintain the composition and function of the resident biological community. • The dissolved oxygen content may not, generally, be less than 5 parts per million or 60% of saturation.	1%

(Data Source: MDEP Bureau of Land & Water Quality 2006)

Reclassification

From time to time MDEP is required to conduct water quality studies to determine if any changes need to be made to the water classification system. The Board of Environmental Protection is also obliged to hold hearings on the classifications and propose changes. At the very least, this process must occur every three years. Most rivers recommended for reclassification are viewed as having a pressing social or ecological need which can often be achieved with current technology in a reasonable amount of time.

Land Use Regulation Law and LURC (1971)

The Maine Land Use Regulation Commission (LURC) was created in 1971 to oversee the planning and zoning of Maine's townships, plantations and unorganized areas, which have no form of local government. The Commission's jurisdiction includes more than 10.4 million acres and the largest contiguous undeveloped area in the Northeast (Land Use Regulation Commission 2009). MDEP and LURC adopted joint regulations for the processing of applications for hydropower projects, pursuant to the Maine Waterway Development and Conservation Act. LURC is the water quality certifier and permit issuer for all activities located within its jurisdiction (MDEP 2005b).

Maine Endangered Species Act (1975)

The federal ESA of 1973 was designed to protect imperiled, threatened, and endangered species and their habitats. Section 6 of the act provides funding to state wildlife agencies for consultation and assistance (NOAA 2009b). Many states, including Maine, have created their own lists of endangered and threatened species to protect species which may be endangered within one state but not elsewhere.

The Maine Endangered Species Act (MESA) was passed in 1975 due to concern that various species of fish and wildlife were in danger of disappearing from the state(Maine Rivers 2009c). The Maine Department of Inland Fisheries and Wildlife (IF&W) oversees the administration of the act, determining which species should be listed as either threatened or endangered. IF&W then makes recommendations to the Maine Legislature for approval. Once a species is listed, IF&W develops protection guidelines, including protecting the species' "essential habitat" (Maine Rivers 2009c). The act has important implications for rivers, since all activities which require a state or local permit that fall within the habitat of a listed species become subject to review by IF&W.

Today, more than 60 species found in Maine are listed as either threatened or endangered under either ESA or MESA (Maine Department of Inland Fisheries and Wildlife 2007). In June 2009, the NOAA Fisheries Service and the U.S. Fish and Wildlife Service extended protection to Atlantic salmon in the Penobscot, Kennebec, and Androscoggin Rivers (NOAA 2009).

Maine Waterway Development and Conservation Act (1983)

At the state level, hydropower projects are regulated under the 1983 Maine Waterway Development and Conservation Act (MWDCA). The act requires that a permit be issued for the construction, reconstruction, or structural alteration - including maintenance and repair - of a new or existing hydropower project. The MWDCA includes a comprehensive state permitting process for projects in organized municipalities - which are administered by the Department of Environmental Protection - as well as in the organized territories - which are administered by the Land Use Regulatory Commission (LURC) (MDEP and Maine Department of Conservation 2009).

The MWDCA ensures that the state only approves an application when it finds that the project has met standards in the following areas:

- Financial Capability: The applicant has the financial and technical wherewithal to support the project through completion.
- Safety: The applicant has made provisions to ensure public safety.
- Public benefits: The applicant has demonstrated that the project includes the creation of potential employment opportunities.

- Traffic Movement: The applicant has made provisions for all traffic generated by the project.

- Environmental Mitigation: The applicant has considered the environmental impact of the project, and made reasonable effort to mitigate any environmental damage caused by the project.
- Environmental and Energy Considerations: The applicant has demonstrated how the project will significantly affect fish, wildlife, soils, coastal waters, shoreline, historic resources, public usage, flood control, and/or non-renewable fuel usage.
- Water Quality: The applicant has realized if the project will alter water temperatures, exceed 30 acres in surface area, or have any upstream direct discharges (other than cooling water).

A 2003 amendment to the MWDCA requires applicants to hold public information meetings prior to filling the application.

Maine Rivers Policy (1983)

This general policy guides the state's management of rivers. The first clause sets the legislature's tone of valuation: "[sic] the State's nearly 32,000 miles of rivers and streams comprise one of its most important natural resources, historically vital to the state's commerce and industry and to the quality of life enjoyed by Maine people." The Maine Rivers Policy sets forth the goal of stimulating a balanced approach towards rivers, which includes (MRS Title 12 Chapter 200 1983):

- Restoration of waterways
- Revitalization of waterfronts
- Maintenance of scenic beauty
- Interests of riparian owners
- Hydroelectric power
- Hydropower (traditional water power)
- Fisheries
- Recreation
- Preserving outstanding river stretches

Natural Resources Protection Act (1987)

In accordance with the general values adopted in the Maine Rivers Policy, the Natural Resources Protection Act (NRPA) aims to identify the significant role natural resources have in creating and maintaining state character and identity. The act requires that individuals engaging in construction-like activities within 75 feet of a protected resource must first acquire a permit. Applicants must demonstrate that the proposed "activity" does not interfere with existing uses of the resource or cause environmental disturbances. Importantly, the act also prohibits any part of the "activity" from crossing a

river segment that the legislature has identified as "outstanding" unless there is no other alternative that has a less adverse impact on the river (MDEP 2005b).

Non-point Source Pollution Program (1991)

In an effort to limit pollution from all sources, Maine implemented the Non-Point Source Pollution Program (NPSPP) in 1991. Recognizing that the majority of the pollution entering water bodies in Maine comes from sources that are not direct dischargers, the legislature has tasked state agencies with the development of "best management practice guidelines." These guidelines detail the recommended techniques or procedures that may be the most effective practicable means of preventing or reducing pollution from non-point sources, which include, but are not limited to, agriculture, forestry, transportation and development (Maine Rivers 2009c).

Stakeholders

Rivers provide a diverse wealth of recreational, industrial, cultural, aesthetic, and economic value to the state of Maine. River ecosystems provide important services and support a diverse variety of biological life. Unsurprisingly, the stakeholders with vested interests in rivers are also diverse and numerous.

Government Agencies

Municipal, state, and federal government agencies are included in river health monitoring and dam maintenance and removal. Agencies such as the Fish and Wildlife Service (USFWS), the Army Corps of Engineers (Corps), and the Federal Energy Regulatory Commission (FERC) monitor and issue permits at the federal level, while the Department of Inland Fisheries and Wildlife (IF&W) and the Maine Department of Environmental Protection (MDEP) monitor river health and fish habitat and population levels at the state level. Municipal governments are less concerned with river health but frequently become involved in dam removal conversations. Each level of government and agencies within have their own mission statement and mandate. These stated priorities can overlap and sometimes conflict, causing increased complications in any proposed removals or data gathering projects.

FERC regulates interstate energy transmission and licenses hydropower projects. They have the power to grant the license to build a dam, or to refuse to issue a license to a proposed project. Once the dam is built, and the license expires, FERC has the power to renew the license or, as of the

1994 internal ruling by FERC, to refuse to renew a license and subsequently mandate removal. In any licensing situation, FERC must not only consider power needs but also the needs of surrounding communities, the environment, river health and habitat, recreational value, and the input of other specialized agencies including the USFWS, the EPA, and the MDEP (Federal Energy Regulatory Commission 2009b).

USFWS is mandated to work with other groups and agencies to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. USFWS and MDEP are jointly committed to the continued monitoring of Maine's environment and the protection of its natural habitats and resources. If any proposed federal project might have a harmful affect on the environment, they can mandate clean-up, block the project, or mandate dam removal (U.S. Fish and Wildlife Service 1999).

The Corps ensures the proper construction and maintenance of any facilities in or along navigable interstate waterways. If any construction occurs then the Corps must issue permits. These permits not only ensure safety but also, working with DEP and USFWS, ensure that no adverse harm will occur to the natural environment, particularly to endangered species (U.S. Army Corps of Engineers 2009).

IF&W works with MDEP to ensure proper compliance with ESA and MESA in order to guarantee that all proposed projects comply with the above listed acts. IF&W develops recovery plans for endangered species, and any proposed dam can be denied or a current dam can be forced to be removed should it significantly harm an endangered species or its habitat (Maine Rivers 2009a).

Other agencies include any municipal governments that may become involved, or district organizations such as LURC which oversees planning and zoning in Maine's unorganized territory.

Communities

Homeowners' associations are only sometimes involved with river health, although some environmentally-minded organizations can embark on grassroots movements to clean up a river. Frequently, however, homeowners' associations become involved with dam removal proposals. Preserving the status quo of river levels and environment, the loss of jobs, and worry over changes in water levels and river flow are frequently reasons cited by these associations as a protest against dam removal. Homeowner's

associations have had limited influence in past dam removal occurrences but they remain an interested stakeholder (Goode 2009).

Native American tribes may have reservations along dammed rivers and by law under the Federal Water Power Act their concerns must be addressed by FERC when considering any dam construction or removal. As a semi-autonomous body, Native American tribes have a special body of rights when it comes to changing the character and nature of a river. Native Americans have distinct cultural and historical ties to the rivers which have been used for hundreds of years as fishing grounds, navigational routes, and as sources of food, water, and spiritual health. Their rights to the river must be considered in any proposed project that affects the health of a river (USC Title 33 § 518. 2002).

In Maine, the Penobscot River Restoration Trust (Case Study 2.1) included the Penobscot Indians who lived upstream of the two dams that were being proposed for removal. The Penobscot Indians had lost the ability to use their traditional fishing rights on the water since dams further downriver of their lands prohibited diadromous fish to travel far enough upstream for them to be accessed. With the proposed dam removals, the opportunity for fishing will be renewed, and their traditional fishing rights restored. They have a representative on the board of trustees that is overseeing these removals, and since they were included as a stakeholder, additional clout was brought to ensure the removal of these two dams(Penobscot River Restoration Trust 2005-2009).

Recreational and Environmental Non-Profits

Local, state, and federal non-profit organizations are crucial supporters and defenders of Maine's waterways. Driven by a desire to preserve the cultural, ecological, recreational and economic assets that rivers provide, non-profit groups endeavor to promote their causes through grassroots campaigning, litigation, fundraising, watchdogging, and negotiation. Several of these groups are described below. While there are dozens of groups holding a stake in Maine's rivers, the following groups may be seen as typical of the types of groups involved due to their enduring record of involvement.

Environmental Protection and Restoration Groups

The Natural Resources Council of Maine (NRCM) is a non-profit membership organization that works to protect, restore and conserve Maine's environment. NRCM focuses specifically on enhancing the quality of Maine's rivers, eradicating toxic chemicals from the environment, and decreasing atmospheric pollution. The organization boasts over 12,000 supporters and

was a crucial advocate for the removal of the Edwards Dam. A sister organization, Maine Rivers, was borne out of NRCM's desire to take a more unified approach on river issues. Comprised of representatives from a broad coalition of environmental and recreational interests, Maine Rivers advocates the return of native fish to rivers and supports efforts to monitor and reclassify rivers (Natural Resources Council of Maine 2009).

Recreational Fishing Groups

The Maine Council of the Atlantic Salmon Federation (MC-ASF) is an umbrella organization that aims to protect Atlantic salmon and other native diadromous fish. Since dams create recognizable barriers to diadromous fish spawning, MC-ASF advocates for the removal of dams or, when necessary, the installation of fish passage systems. MC-ASF was also key in securing federal protection and funding for endangered Atlantic salmon in eight Maine watersheds(The Maine Council of the Atlantic Salmon Federation 2004-2009).

Case Study 2.1 The Penobscot River Restoration Project

In 1999 Pennsylvania Power and Light Corporation (PPL) purchased three dams on the Penobscot River in Maine, setting in motion a unique river restoration project. PPL, the Penobscot Indian Nation, conservation groups, and the state and federal governments cooperated to produce a distinctive agreement. The three dams were purchased by the Penobscot River Restoration Trust. Two of these dams are to be removed and a third depowered and a state-of-the-art bypass built around it. PPL will also construct fish passage at four additional dams. In return, PPL will be able to increase power generation at six other dams(Penobscot River Restoration Trust 2005-2009).

Instead of fighting before a court over dam removal, the interested stakeholders collaborated to form an agreement mutually beneficial to the parties involved. Fish will be able to once again migrate up the Penobscot River, and the Penobscot Indian Nation will be able to fish from the banks of the river. While not all stakeholders were included (riverside communities were not involved in the agreement) it has set a precedent for dam removal in the future. By working with the state and federal governments, FERC, FWS, and NOAA, the members of the agreement were able to avoid many of the pitfalls that previous dam removal proponents have met with and instead formed a result that was agreeable to all. By including all stakeholders' interests they did not need to resort to legal action. By demonstrating a new procedure for dam removal, the Penobscot River Restoration Project has broadened the opportunities for dam

removal(Natural Resources Council of Maine 2009b).

In August, 2009 the Penobscot River Restoration Trust exercised the option to purchase the three dams. Demolition of the two dams slated for removal is scheduled to occur in 2010 or 2011 (The Nature Conservancy 2009a; Natural Resources Council of Maine 2009b)

Industry

Industrial activity along rivers has become an indelible part of Maine's culture, affecting both rivers and people from the time the first paper mills began operation in the 1850s. Rivers have served as transportation for lumber, discharge receptacles for dyes and chemicals, sources of hydroelectric power, fishing grounds, and tourist attractions. While many of these industries have receded from Maine, notable industrial stakeholders are still active:

The Maine Pulp & Paper Association represents the pulp and paper industry in Maine, which is still a major industrial force along Maine's rivers, even though the number of working mills has declined (Maine Pulp and Paper Association 2009). Pulp and paper companies in Maine are subject to discharge regulations under both federal and state law. In 2004, twelve mills were still operating within the state (Maine Forest Service and Maine Technology Institute 2005).

Hydropower accounts for about 30% of all electricity produced in Maine (State of Maine Public Utilities Commission 2009). Maine's 179 hydro-electric dams are owned and operated by numerous companies, some residing in-state, some licensing from out of state (Maine Department of Marine Resources 2008).

Finally tourism is important. In 2006, tourists to the state spent nearly $1 billion on lodging, $3 billion on food, and $1 billion on recreation (Maine Office of Tourism 2008). The Kennebec and Moose River valleys have become significant hubs for recreation and tourism, offering kayaking, rafting, canoeing, fishing, and hunting along the rivers. A unique diversity of fish draws visiting anglers, and historic river towns have become attractive tourist destinations.

State of the Topic

In this section we present an overview of the current status of rivers and streams, dams, fish bypasses, and dam removal in Maine. We focus on the

state of the issues, the current trends, and describe ongoing actions related to dam removal and river restoration in Maine.

Rivers and Streams

In 1998, EPA prepared a National Water Quality Inventory as required by CWA. Each state was required to evaluate the health of all bodies of water, from wetlands to lakes to rivers and streams, based on criteria such as aquatic life support, fish consumption, swimming use, and drinking water. States were not required to evaluate every mile of river, and indeed, Maine was among only three states to assess all its 31,752 miles.

Ninety-nine percent of Maine's rivers are considered to fully support aquatic life uses (Table 2.1), the highest percent of rivers that fully support aquatic life in any state. In comparison, 58% of rivers and streams nationwide fully support aquatic life. Ninety-nine percent of Maine's rivers also fully support fish consumption and 99% fully support primary contact (swimming), compared to nationwide averages of 87% and 69%, respectively. This is a significant improvement over the years before CWA when many of Maine's rivers were among the nation's most severely polluted rivers, from paper and textile mill, sewage, and city discharges (EPA 1998).

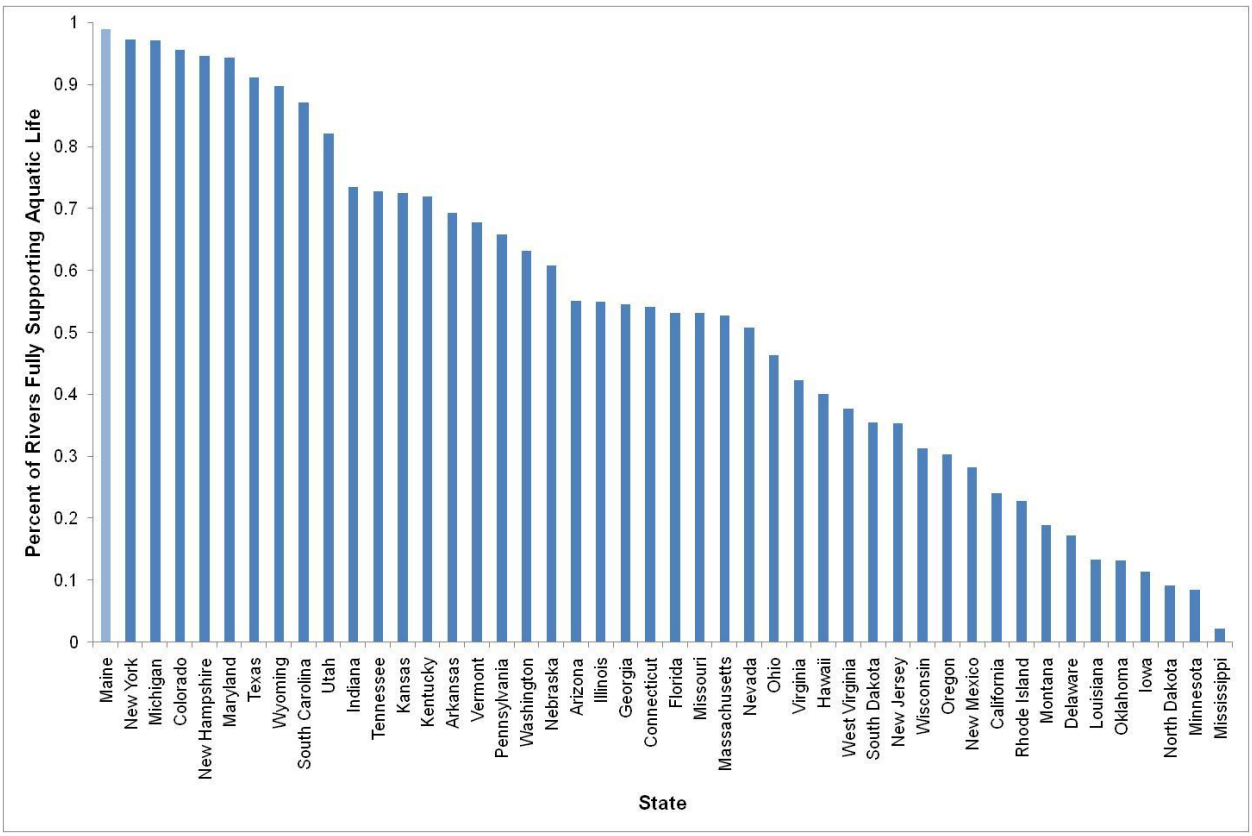


Figure 2.1 Percentage of assessed rivers that fully support aquatic life during 1998 EPA assessment, by state (Data Source: EPA 1998). Maine is in light blue.

In addition to the standards set in 1972 by CWA, the Maine Bureau of Land & Water Quality (BLWQ) has had a river and stream classification system for over 50 years. The purpose of the system is to create water quality goals for the state of Maine by evaluating the risk level of a particular river or stream. By establishing this management system for the protection of Maine's waters, the BLWQ can designate permitted uses, establish the necessary guidelines to protect those uses, and limit certain activities such as pollution or wastewater releases (MDEP Bureau of Land & Water Quality 2006).

The classification system has four classes for rivers (Table 2.3). These classifications can be updated as necessary based upon the necessity for additional protection or increased ecosystem health. For example, when the Edwards Dam was removed on the Kennebec River, the stretch of river where it was located improved from a Class C rating to a Class B rating within 2 years, representing improved river health and changed uses (Goode 2009). Downgrades in classification are rare and not encouraged but can be made if necessary (MDEP Bureau of Land & Water Quality 2006).

Only seven percent of Maine's rivers are classified as AA, and these rivers are generally protected within a park or preserve such as Baxter State park or Acadia National Park (Figure 2.2). Since no direct discharge is permitted in these rivers, this classification is used carefully. Class A is allotted to much of Maine's North Woods, where discharges are limited and population is sparse. Fish spawning areas, for those fish that can reach the upper reaches of the rivers, are protected here, as is all aquatic life. Class B is generally allotted to areas with increasing numbers of people, where some discharges are permitted. Finally, Class C, only 1% of Maine's rivers, permits some discharges that may affect aquatic life. However, the biological community must remain viable, and all classes must maintain the minimum fishable-swimmable standards of the CWA (MDEP 2005c).

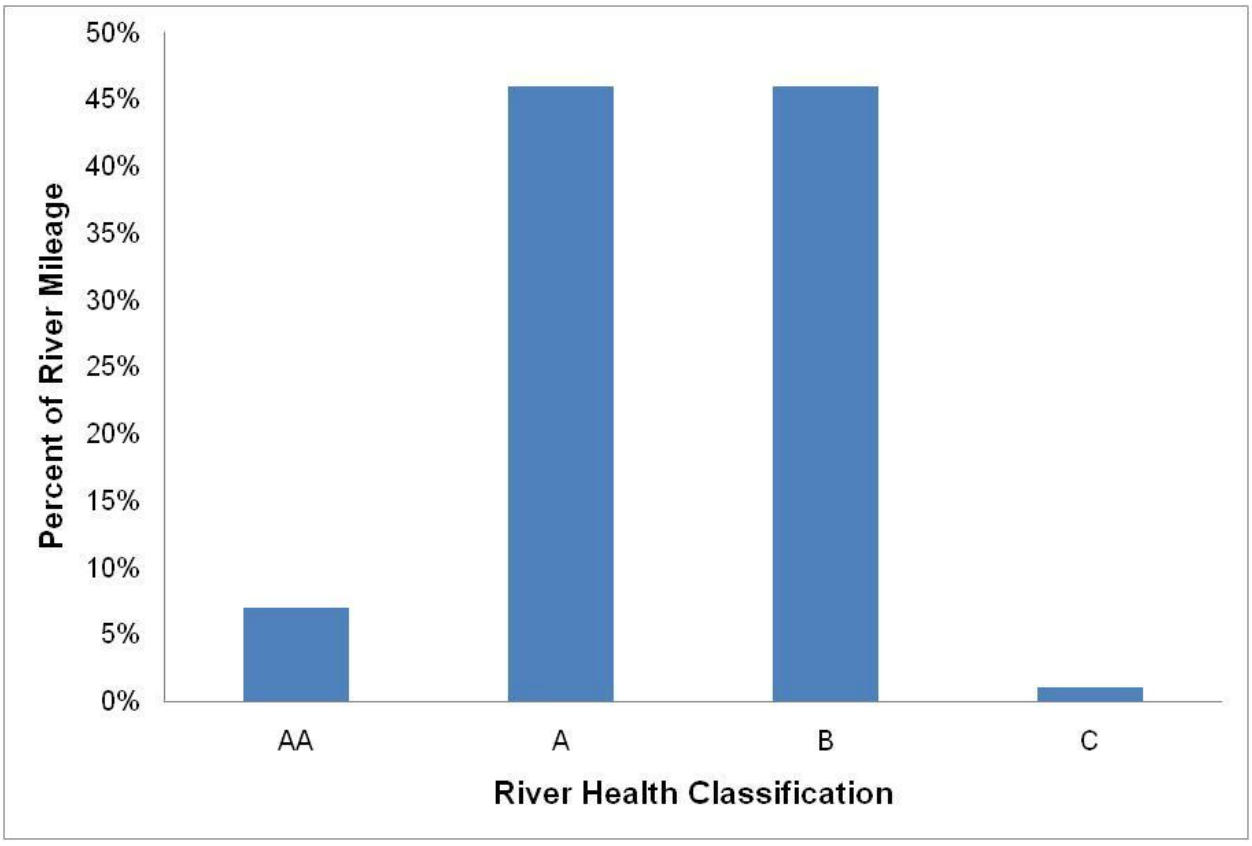


Figure 2.2 Classification of Maine's 31,752 miles of rivers according to the state river health classification system (Data Source: MDEP Bureau of Land & Water Quality 2006).

In sum, most of Maine's rivers and streams are currently in an excellent state of health, especially when compared to the rest of the U.S. The risk classification system used by BLWQ is an effective way to continue to monitor ecosystem health as well as regulate pollution discharges.

Dams

There are 782 dams in Maine, which have been built for a number of purposes including water storage, flood control, navigation, and hydropower. This figure is paltry, however, compared to the number of dams in many other states. Figure 2.3 shows the number of dams per state normalized by the miles of rivers in each state. We used data from the National Inventory of Dams (NID) because this was the only available data for number of dams for every state. NID lists only dams above a certain height or dams at a certain public safety risk and this may skew the data somewhat since many of Maine's dams are small. However, it does show that Maine generally has fewer dams than most states.

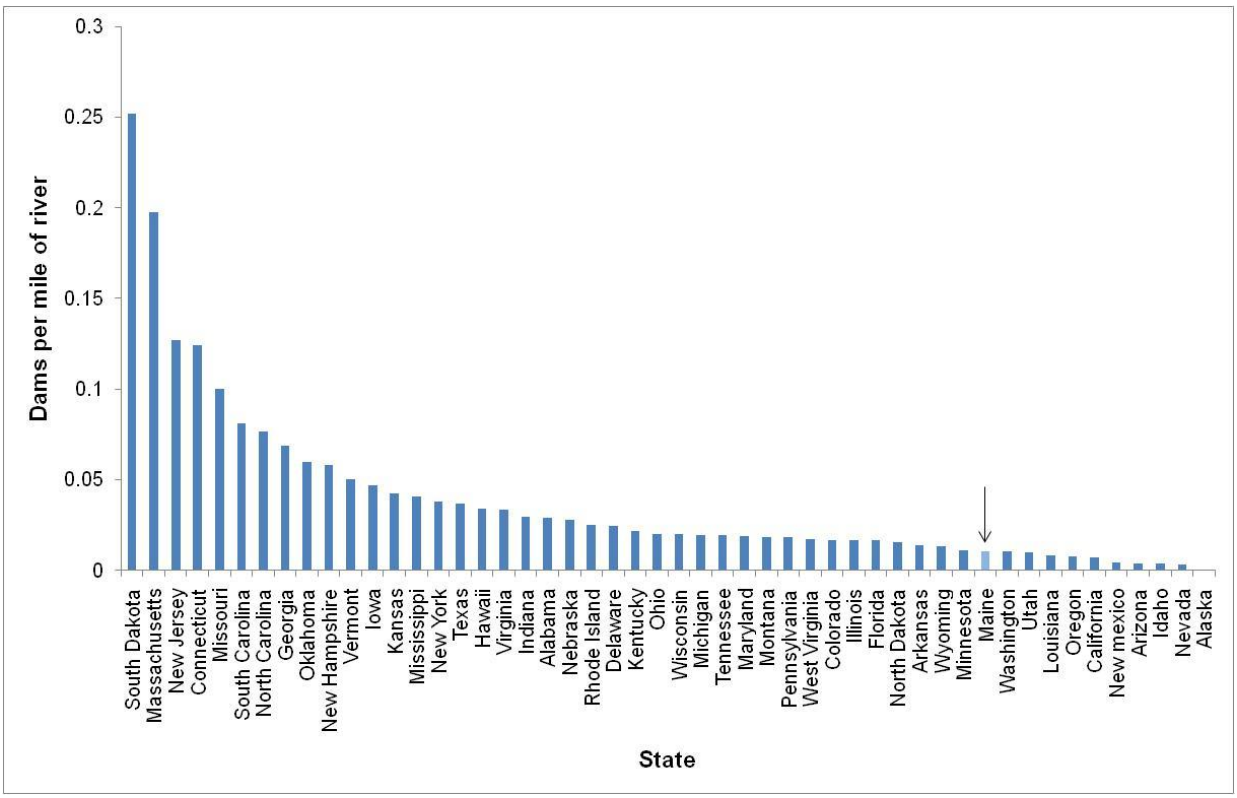


Figure 2.3 Number of dams listed under the National Inventory of Dams index divided by miles of rivers per state (Data Sources: EPA 1998; U.S. Army Corps of Engineers 2007). Maine is in light blue.

The rate of dam building in Maine grew slowly from 1800 until 1880 (Figure 2.4). Early dams were predominantly built for water storage, and many of Maine's towns and cities are still located on small stillwaters created by these dams (GIS Data Catalog - Maine Office of GIS 1987). They provide areas for recreation and fishing, as well as provide flood control and fresh water. Other early dams were built by logging and paper companies to

facilitate log drives. Log jams were frequent, especially at steeper drops in the river, and dams offered a safer solution by covering trouble spots in water, as well as providing a storing place for the logs in the stillwater behind the dams.

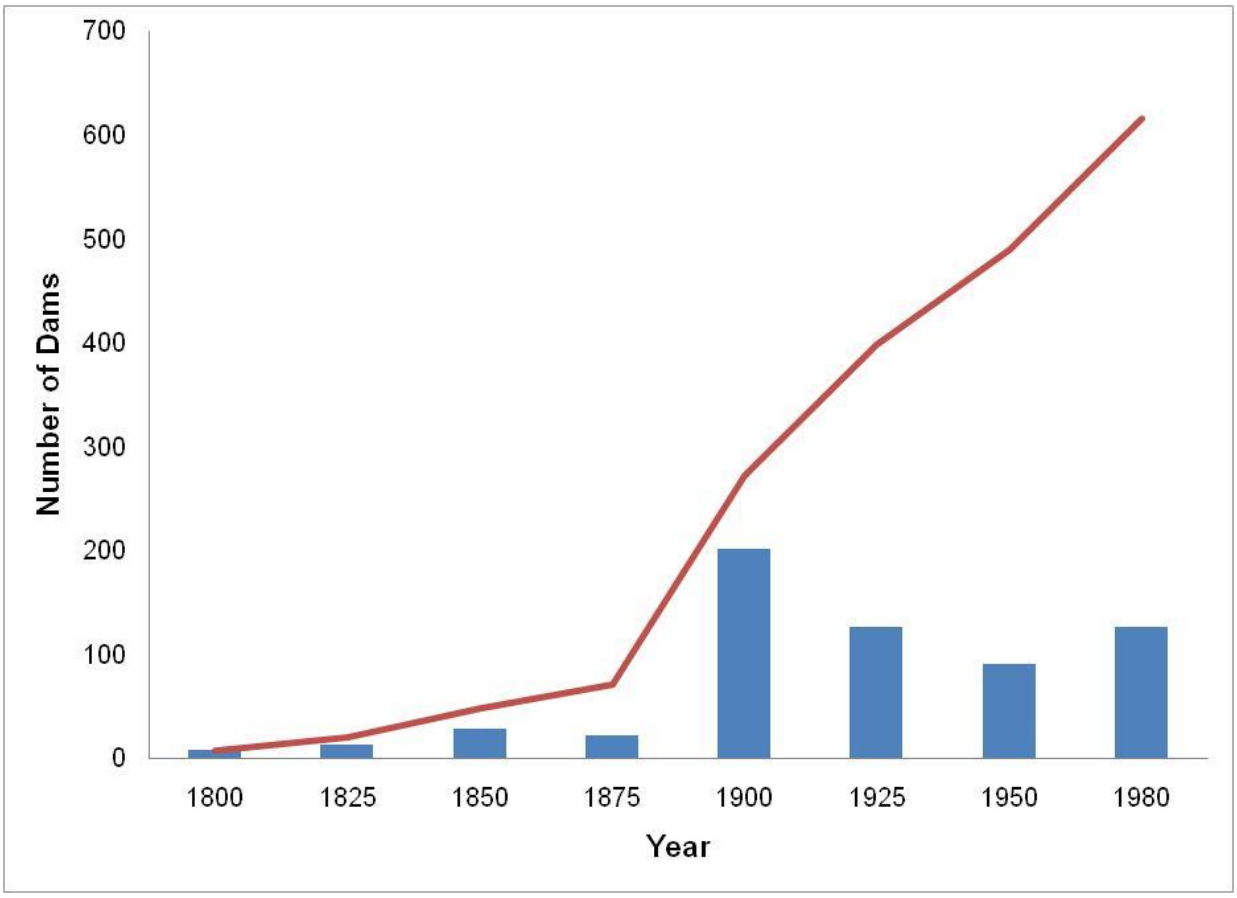


Figure 2.4 Number of dams built in Maine every twenty-five years from 1800 to 1980, and cumulative dams built (Data Source: GIS Data Catalog - Maine Office of GIS 1987).

In 1880 the water turbine was developed in Michigan, initially powering street lighting (U.S. Department of Energy 2008). Breakthroughs followed quickly and many of the dams built in 1900 and the following years were hydropower dams, powering many of the growing Maine towns (Figure 2.4). Most hydropower dams in Maine are what are known as "run of the river" dams which, unlike many of the large dams in the west, create only a small reservoir that diverts the river through turbines to generate electricity (the Flagstaff Dam is an exception).

The most recent dams built in Maine have been constructed to control flooding, but no dams of significant size have been built in the last 30 years.

We suggest that factors curbing dam construction include: a stricter permitting process, increased knowledge of potential environmental risks, and a decreasing number of suitable locations.

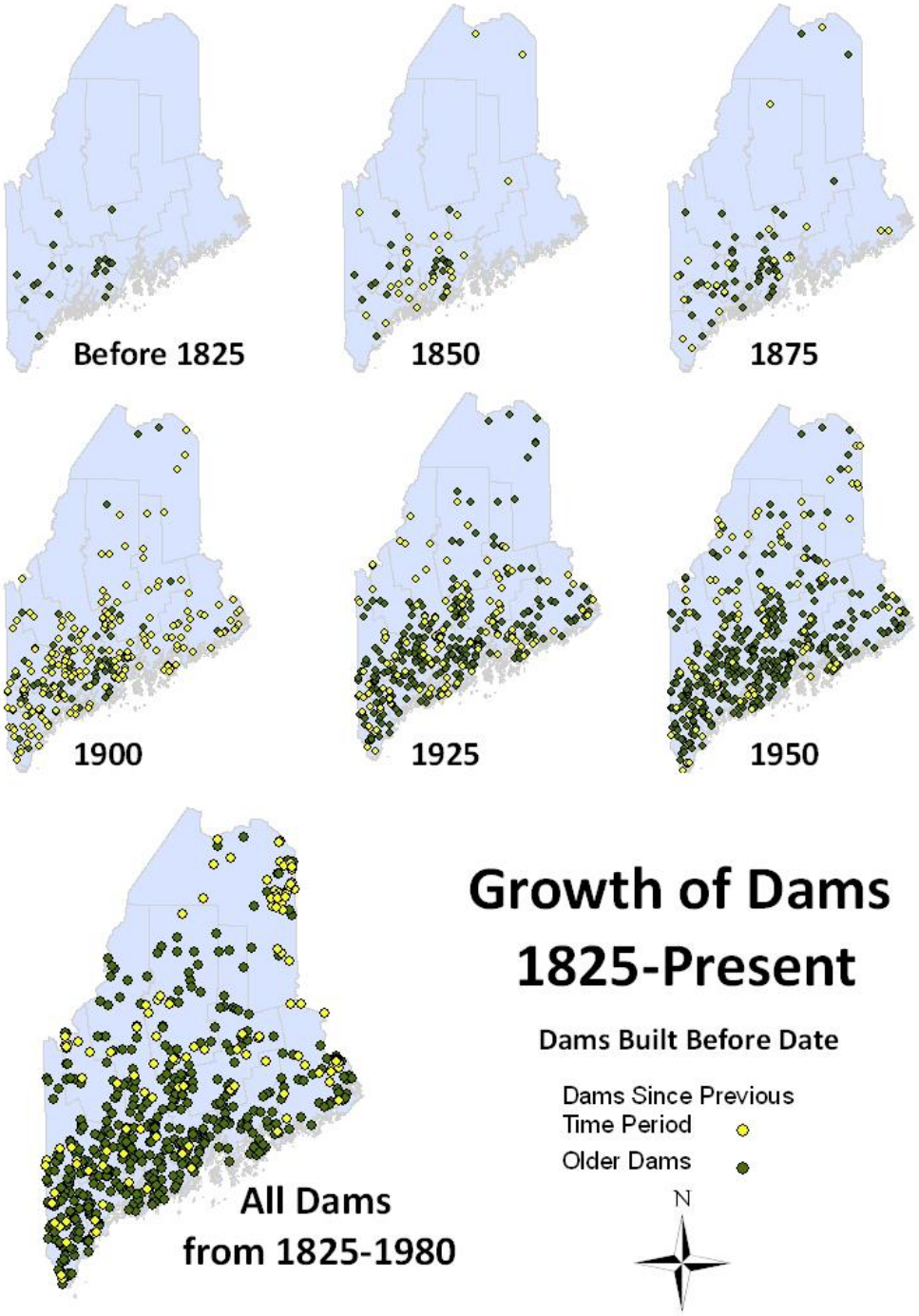


Figure 2.5 Number of dams constructed from 1825-1980 (Data Source: GIS Data Catalog - Maine Office of GIS 1987).

Dams have been built throughout Maine (Figure 2.5). They are focused generally in the southern part of the state, but have been built throughout. The large increase around 1900 is due primarily to the development of the turbine, and demonstrates a time of growth in dams in Maine.

One of the most striking differences between dams in Maine and those in the rest of the U. S. is the average age of dams. Maine's dams are significantly older than an average U.S. dam (see Figure 2.6), and no dam has been built since 1980. Nationwide dams are, on average, about 51 years old (American Society for Civil Engineers 2009). Additionally, 85% of dams will near the end of their operational lives by 2020 (Doyle, Stanley et al. 2003). Maine's dams are, on average, older than U.S. dams at 94 years of age(GIS Data Catalog - Maine Office of GIS 1987). Therefore, it logically follows that greater than 85% of Maine's dams will near the end of their operational lives by 2020. This poses significant safety concerns for Maine. As dams age, they fall into disrepair. Maine does not have a comprehensive management plan to deal with aging dams.

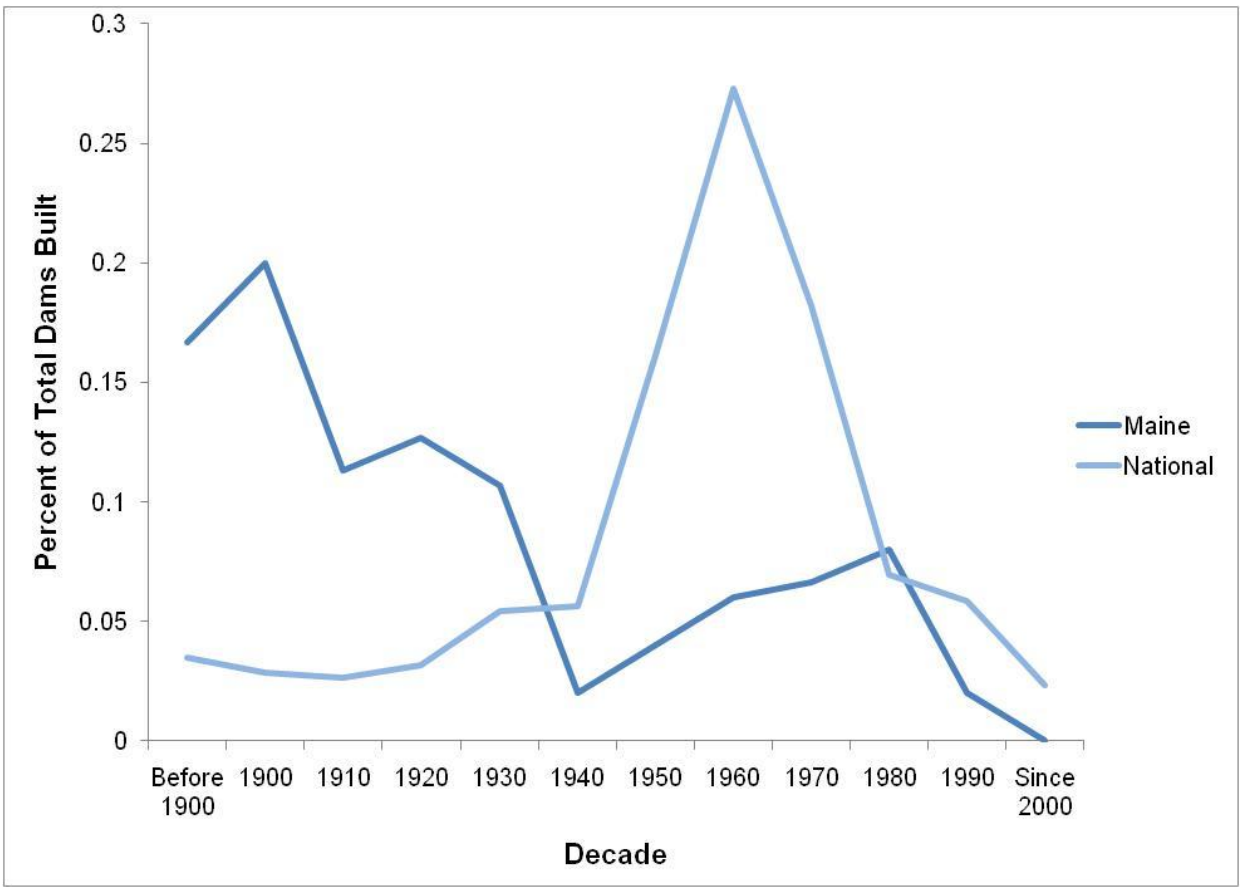


Figure 2.6 Percentage of total dams in Maine built per decade versus percentage of total dams U.S. built per decade (Data Source: U.S. Army Corps of Engineers 2007).

Maine currently has only one State Dam Inspector (SDI), with the Maine Emergency Management Agency (MEMA). MEMA inspects all Maine dams in a rotating fashion. Currently more than 15% of inspected dams are considered high-hazard-potential or significant-hazard-potential dams. Seventeen of the high-hazard-potential dams currently need over $12 million in repairs, demonstrating just how significant an effect aging has had on Maine's dams (American Society for Civil Engineers 2008).

Another facet of the dam aging problem in Maine affects only hydropower dams. The Federal Energy Regulatory Commission (FERC) regulates all hydropower dams in the U.S. FERC issues licenses for hydropower dams for 30-50 years. Since many of Maine's dams are aging, many of FERC's permits are coming up for re-licensing soon (Figure 2.7).

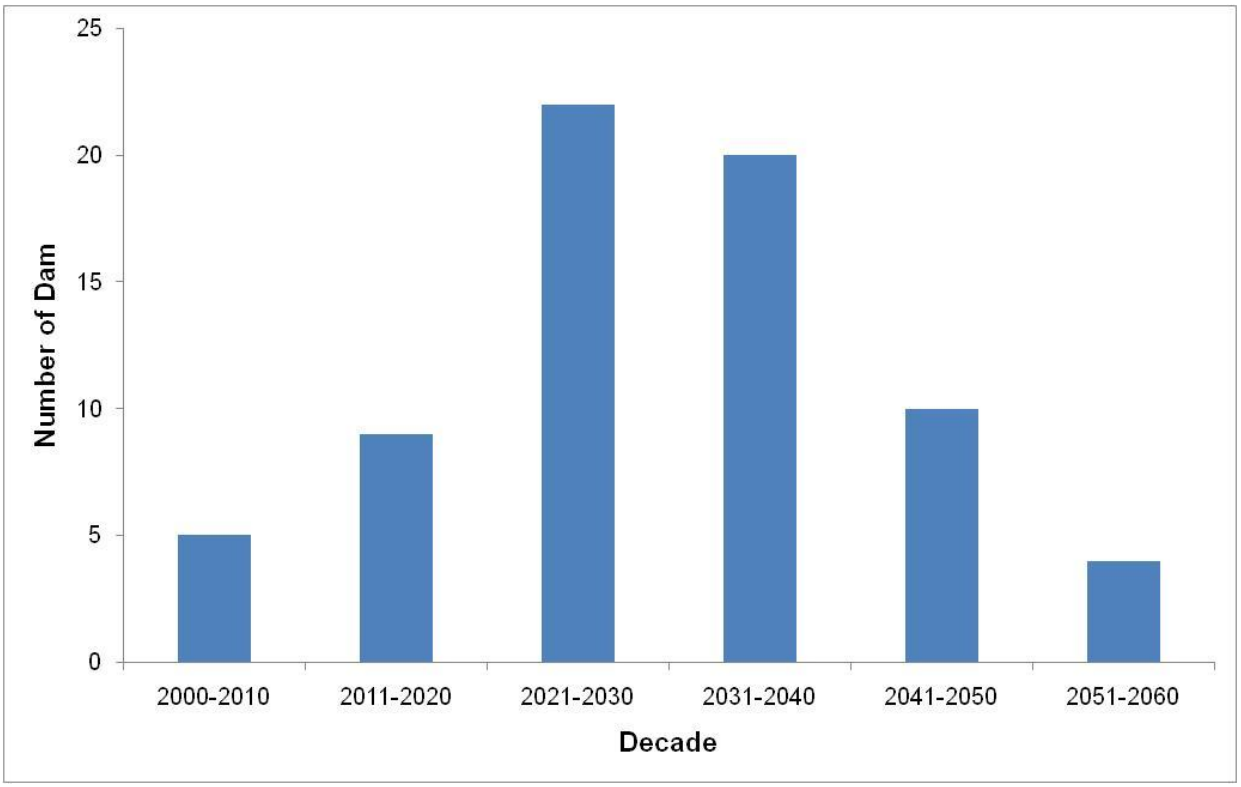


Figure 2.7 Expiration dates of FERC permits for hydropower dams in Maine by decade (Data Source: Federal Energy Regulatory Commission 2009a).

There are 35 dams in Maine that will have their FERC licenses expire within the next 20 years. In 1994 FERC issued an internal ruling stating that they can now refuse to relicense a project if it is decided that the social and environmental benefits of removal outweigh any power benefits of continued upkeep. The Edwards Dam on the Kennebec River in Maine became the first and only dam to be removed by FERC mandate. The ruling was appealed by dam owners only to be upheld by FERC. The removal took place in July of 1999 (Natural Resources Council of Maine 2009).

So what does all this mean for Maine? We have demonstrated that while Maine does not have a significant number of dams when compared to the rest of the nation, what Maine does have are dams that are older than much of the nation. This means that Maine will need to confront aging dams sooner than most other states. Either significant repairs need to occur on these dams, or other routes need to be taken to prevent hazards, such as removal. Removal is increasingly being used as a viable option. As dams age and fall into a state of disrepair, upkeep can become expensive. Many of Maine's dams are no longer being used for their original purposes, and simply remain standing as historical reminders of an earlier time. As maintenance costs mount, owners increasingly have been looking to

removal. Additionally, as FERC-issued permits expire, relicensing schemes will take into account the biological effects of dams on rivers. Dam owners are also considering dam removal not only as a cost-saving measure but as a way to return the rivers to their natural states.

Recently, considerable research has been done on the possible environmental effects dams have on river and surrounding ecosystems. Dam impacts differ from region to region and river to river, but there are several general effects that most dams have on river and shore habitats. Dams create reservoirs, flooding valuable shoreline habitat. These reservoirs also interrupt the natural flooding cycles of a river, halting the distribution of species and impeding natural disturbances that keep the ecosystem balanced (Bednarek 2001). Dams restrict the movements of fish and other migratory aquatic species(Goode 2006). Dams affect the natural river movements, including high and low water levels and temperatures, which can affect the ecosystem(Poff and Hart 2002). Finally, dams collect sediments and pollutants behind the impoundment, causing dangerous levels of some chemicals and heavy metals(Stanley and Doyle 2003). These effects can have significant repercussions for both dam construction and removal policy.

Fish bypass systems

Dams create an impassable barrier to migrating species. Diadromous (migrating) fish are some of the most significantly affected species, since they cannot pass dams to continue to their spawning grounds. In the late 18thcentury fish ladders were developed to combat this problem by creating a ramp constructed of a variety of materials such as rock, concrete, or wood to allow fish to swim around or over a dam. They are a series of steps with pools of water that enable fish to jump from level to level, slowly rising until they reach the top of the impoundment. Unfortunately, fish ladders need to be precisely engineering since too little flow down the ladder will result in the fish not being attracted to it, while too much flow will tire out the fish and not permit them to swim upstream.

Fish ladders vary greatly in their effectiveness. Different species of fish prefer different levels of water flow and different jumping heights between pools, so comprehensive studies are difficult to perform (Jungwirth, Schmutz et al. 1998). One study on the Deerfield River in Massachusetts found fish bypasses around dams to be between 15% and 81% effective for migrating smolt depending on the modifications made to the dams, demonstrating the extreme variability in fish bypass effectiveness (Ragonese 2004). It can simply be noted that all species demonstrate at least some loss of successful migration numbers. Notable exceptions to this rule are sturgeon, striped

bass, and rainbow smelt, which have never been proven to successfully use a fish ladder (Goode 2006). Examining Appendix A we note that these species' habitats extend not much further than the high tide mark_._ Downstream migrations can be just as deadly to a fish population. While fish can't move up the outflow from the turbines since the flow is so powerful, they can be sucked into the turbines when moving downstream. The American eel is particularly affected by this problem and has seen up to 100% mortality of some populations. Additionally, some other species such as the American shad rarely use ladders, and so a newer technology, the fish elevator, must be used for an increased success rate (Goode 2006).

Fish elevators represent another viable form of fish passage. Fish elevators also use flow to attract fish into a holding pool. The fish are then forced into a tank filled with water and lifted over the dam, to be deposited above in the stillwater. Fish elevators are more efficient for species such as shad, but require increased maintenance and operating costs over the traditional fish ladder (Larinier 2000). Increasingly environmental groups and the government are promoting the use of elevators since they have been shown to increase successful fish migration.

Other means of moving fish around dams include the incidental use of navigational locks, as well as trucking or flying fish around an obstruction. These are neither efficient nor cost effective and are used infrequently (Northwest Power and Conservation Council 2009).

Recently, more care has been taken by governing agencies to ensure that dams have less effect upon migratory fish populations. FERC now must consider the ecological value of migratory species when conducting their cost-benefit analysis of a dam. As part of the relicensing scheme, FERC can require the construction of a fish ladder or elevator (Goode 2009). Additionally, some dam owners are voluntarily building fish bypasses to facilitate migration. Environmental groups are increasingly recognizing that fish elevators, while also not 100% effective, are a reasonable alternative to dam removal, since removal is a longer, more arduous and complicated process (see "Dam removal" section below).

Maine has reviewed their statewide fish passage efforts and prioritized all fish bypass systems on all watersheds based upon the effects on fish migrations. The report, entitled *DMR Review of Statewide Fish Bypass Efforts*, recommended that the Maine Department of Marine Resources (DMR) and the Maine Department of Environmental Protection (DEP) work together to implement the priority fish bypass projects(MDMR 2007). The evaluation was conducted on a state-wide basis for only hydropower dams, and it was found that 45% of hydropower dams are within the historic range

of alewives, American shad, and blueback herrings, 53% within the range of Atlantic salmon and 65% within the range of the American eel (MDMR 2007). The DMR evaluated hydropower dams since these are most often on the main stem of rivers and therefore directly affecting fish migration. The Saco, Presumpscot, Kennebec, Damariscotta and Penobscot Rivers all received a high restoration priority and in the coming years DMR will be emphasizing river restoration and fish bypass construction efforts in conjunction with the FERC relicensing process to improve river quality and fish migration throughout the state (MDMR 2007).

Dam removal

While river health is excellent in Maine, Diadromous fish populations are shrinking. Fish bypass systems are only partially effective, so dam removal has appeared as a viable alternative to help restore these fish populations, as well as increase public safety. Hundreds of miles of habitat have been cut off from fish populations (see Appendix A), and dam removal is intended to restore historic habitat, revitalizing lagging species. Dam removal is a growing trend in Maine, with 17 removed dams and 12 more under consideration for removal, but involves a long and complicated process. Dams can be removed in several ways:

First, a dam owner can decide to remove a dam privately. A number of permits are still needed (described below), but since the removal is voluntary, the process is less complex.

Second, the federal government can mandate removal. The Federal Energy Regulatory Commission (FERC) oversees all hydro-power dams not owned by the federal government (see above in "Government Agencies"). These dams have licenses lasting from 30-50 years, and must be renewed by the owner when they expire. If the power company decides to renew its license, then there are three options FERC has that lead to removal: relicensing, mandating repairs, and surrendering licenses

- Option 1: FERC can refuse to relicense a project. FERC can decide that it is not in the public's interest to re-license an agreement, balancing both power and non-power needs (e.g. fishing, wildlife, recreation) in a cost-benefit analysis, FERC can decide that the dam is not worthwhile (see Case Study 2.2) (Bowman 2002). FERC can also make re-licensing agreements with large companies who own several dams: FERC will re-license some dams on the condition that one or several others are removed. This occurred in Wisconsin and allowed eight dams to be re-licensed on the condition that three others owned by the same company were removed. Finally, as part of the re-

licensing, FERC can require fish ladders or elevators to be installed. Should the dam owner determine these improvements to not be worth the cost, then this can result in removal.

Case Study 2.2: The Edwards Dam and FERC

The 1999 removal of the Edwards Dam marked a turning point in the history of dams in the U.S. For the first time, FERC exercised its authority to remove a functioning hydropower dam with the goal of rejuvenating aquatic ecosystems. This was a revolutionary idea: FERC's decision formalized the notion that dams were tools with designated life spans rather than permanent structures (Lewis, Bohlen et al. 2008).

The removal process was not considered "smooth sailing." Over a decade elapsed between the initial calls for fisheries restoration by the Kennebec River Anglers Coalition and the actual breaching of the dam. During that time, the stakeholders negotiated fervently. When the dam's FERC license to operate the dam expired in 1993, various proposals were put forth, rejected, reconfigured, and resubmitted as the dam's owners—then the city of Augusta and Edwards Manufacturing Co.—fought to retain their right to produce electricity at the facility. After initially recommending a relicensing contingent upon the inclusion of a migratory fish passage, FERC reversed its preliminary decision, declaring that the environmental and economic benefits of removal outweighed the benefits of continued hydropower production (Natural Resources Council of Maine 2009).

The removal was a first for Maine, and a first for the nation. Within one year eight species of sea-run fish had been restored to the reopened habitat, and the Kennebec's health classification had been raised from class C to class B (American Rivers 2009). Today, the Kennebec flows freely from Waterville to the sea and the upstream communities of Benton and have renewed commercial harvests of river herring (Natural Resources Council of Maine 2009).

Only very limited ecological studies of the after-effects of the dam's removal have been undertaken (Goode 2009). It was recently shown, however, that property values near the former dam site have increased due to positive changes in water quality (Lewis, Bohlen et al. 2008).

- Option 2: FERC can mandate repairs or improvements (such as a fish bypass) to be made to a dam as part of the safety inspections that occur about every five years. If FERC mandates repairs, and the

owner finds them to be too costly, then the removal process may begin.

- Option 3: FERC can accept the surrender of a dam's operating license. If a dam owner wants to stop using the dam to produce power, then he/she must seek approval from FERC to surrender the license. As part of this depowering agreement, FERC can order the dam to be removed, though as of yet this has not been done, and FERC has simply issued the license surrender or nonpower license without mandating removal (Bowman 2002).

Third, dams can also be removed by the state. The Maine Emergency Management Agency (MEMA) monitors dams in Maine for public safety, ensuring that routine maintenance and upkeep are performed. In an emergency situation, MEMA is permitted to breach or remove a dam if public safety is threatened. Additionally, during the inspection of a high hazard or significant hazard dam (which must be inspected once every 2 and 4 years, respectively) the inspector creates a condition report. Based upon his/her recommendations, the recommendations of the commissioner, and of the dam owner, dam removal can be ordered. This has not occurred in Maine to date (Fletcher 2009).

Fourth, third parties can influence or force dam owners into removal. They can either work cooperatively with dam owners (Case Study 2.1) or attempt to force dam owners to remove dams through litigation, using ESA or MESA (see "Laws and Institutions" section above). There are three different ways ESA can be used, although to date, ESA has not been used solely to mandate removal:

- Option 1: Section 7 of ESA prohibits federal action that jeopardizes the continued existence of an endangered species or its habitat. If an activity jeopardizes the species or its habitat, then USFWS or NMFS must be consulted, and they are authorized to recommend removal as a 'reasonable and prudent alternative'. An example where environmentalists attempted to stop dam construction is the Tellico Dam in Tennessee. The dam was near completion when the snail darter, an endangered species, was discovered in the river. Construction was ordered to halt, and a long battle ensued. The Supreme Court eventually ruled that, under Section 7 of ESA, construction must stop. Congress later exempted the Tellico Dam from ESA, but it still stands as a landmark ruling for the protection of endangered species(Wheeler and McDonald 1986). There are, however, several problems with using Section 7 to enforce a dam removal. 1) Section 7 only applies to the federal government. 2) It

applies only to a proposed action. It is difficult to prove that the continued use of an existing dam is 'proposed action'. 3) It is difficult to prove that existing dams jeopardize a species and that dam removal will remove that jeopardy. 4) It is difficult to prove that future river habitat above the dam where stillwater exists as a result of the dam will be critical habitat for the species in question (Bowman 2002).

- Option 2: Section 9 of ESA prohibits the taking of an endangered species. If it can be proven that a dam is killing an endangered species (turbines, pollution, etc.) then USFWS or NMFS can declare an impermissible taking. Often the result is simply fines, but it could result in eventual removal. If a dam is completely blocking a river, it is difficult to prove a taking since there are no migratory fish nearby to be taken. This clause can also have a reverse effect on removal since removal operations may result in the taking of a species. Finally, USFWS or NMFS can issue an 'incidental' take permit if the take will be small and not likely to adversely affect the species as a whole (Bowman 2002).

- Option 3: USFWS and NMFS are required to design and implement recovery plans to remove endangered species from the endangered species list. As part of a recovery plan dam removal could be required (Bowman 2002).

Federal permits

There are many federal permits required for dam removal, and it can take many years before ground is actually broken on a dam removal project. Numerous agencies must be consulted, and at any step, the removal can be blocked. To illustrate the complicated nature of the process, we list below the federal permits (the laws that address these permits are described above in the "Laws and Institutions section"):

- A Clean Water Act (CWA) section 404 permit from the Corps will be issued if there will be no significant degradation to the water, no net loss of wetlands, no adverse impacts, and no practicable alternatives. It must also be in the public interest. The biggest problem is loss of wetlands since dam removal will often result in a free-flowing river again with few wetlands along the shore. The Corps issued a regulatory guidance letter in 2001 to ignore this provision if the project takes place in a non-wetland habitat. A NPDES permit will be required for any pollutant emissions pursuant to the construction, excavation, and removal activities (Commonwealth of Massachusetts Riverways Program 2009).

- The Corps also issues a Rivers and Harbors Act (Section 10) permit which states that no adverse affects will occur to interstate navigation. Additionally, if there will be any fill, temporary or permanent, used to construct temporary dams while removing the main one, permits are needed from the Corps (MDEP Bureau of Land & Water Quality 2009).

- If FERC is involved, then the owner needs to apply for a surrender of his FERC license or the issuance of a nonpower license (see above).

- NEPA may require the preparation of an environmental impact statement, to look at the myriad of environmental impacts dam removal has.

- ESA must be consulted to determine if any endangered species will be adversely affected (see above).

- Per the Magnuson-Stevens Act, FERC, the Corps, and NMFS need to consult the regional fishery management council to make sure the removal does not adversely affect the fishery if there is a fishery management plan in place for the region.

- The National Historic Preservation Act must be consulted to determine if the dam will affect any historic properties such as nearby sites or the dam itself. Proper paperwork needs to be filled out, but even if the dam is on the National Register of Historic Places, it can still be removed with proper documentation.

- Finally, for the Corps or FERC to issue the above licenses and permits, they may need to consult with the state to ensure water quality and coastal zone management is kept up (Bowman 2002).

State Permits

State permits are also required, and although they are not as numerous as the federal permits, they still complicate an already convoluted process.

- A permit is required under MWDCA to remove hydropower or storage dams.

- In organized towns and cities a NRPA permit is needed, ensuring that public safety is guaranteed, navigation are maintained the environment is protected by maintaining water quality standards and

wetlands, soils, fish and wildlife are considered, historical sites are protected, and public access maintained.

- In the unorganized territory, a development permit is needed from LURC, ensuring the continued maintenance of the environment, existing uses, and natural and historic resources (MDEP Bureau of Land & Water Quality).

Municipal Permits

Municipal permits are often not required. However, in some districts must meet shore land zoning ordinances or development standards (MDEP Bureau of Land & Water Quality).

Overall, the Maine removal process comparable to the initial process required for dam construction. Permits are needed from a number of sources ensuring that environmental, social, cultural, public safety, navigational, and recreational uses are maintained during and after removal. Dam removal is a lengthy and expensive process, but one that is becoming increasingly used over the past several decades.

Analysis of Migratory Fish Habitats and Dams

Dams pose an obvious impediment to traditional fish spawning routes. In this study we aimed to quantify the impact of dams on fish spawning in a useful, but easily understood way. Using GIS data on the historic and current habitats of twelve diadromous fish species we mapped the points where dams and impoundments intersected these habitats. Included in this analysis were dams which have been or will be removed. Our analysis led to two interesting observations: we determined 1) the number of dams intersecting the habitat of a single species, and 2) the number of habitats that each individual dam intersects.

Table 2.4 Number of intersections between dams and habitats, and percent of total dams intersecting habitat by species (Data Sources: GIS Data Catalog - Maine Office of GIS 1987; Maine Office of GIS 2007).

Species	Dams Intersecting Habitat	Percent of Total Dams Intersecting Habitat
American Eel	454	58%
Alewife	272	35%
Sea Lamprey	246	31%
Atlantic Salmon	242	31%
Rainbow Smelt	97	12%
Blueback Herring	93	12%
American Shad	91	12%
Sea-Run Brook Trout	70	9%
Striped Bass	22	3%
Short-nosed Sturgeon	20	3%
Atlantic Sturgeon	20	3%
Atlantic Tomcod	19	2%

We found that the American Eel (*Anguilla rostrata*), whose historical habitat is quite extensive throughout Maine, had the highest number of dam-habitat intersections, with 454 dams (58% of total dams) impeding access to historical habitat. On the low end, the Atlantic Tomcod's (*Microgadus tomcod*) habitat is intersectedby only 19 dams (2% of total dams). We make no assumptions about the harm a species is subjected to by these intersections with dams; we simply observed that dams can limit access to traditional habitat and spawning grounds, and that some species face more of these obstacles than others.

In the second half of our analysis, we focused on the effects of individual dams on multiple habitats. In river ecosystems, the emergence or disappearance of a single keystone species may have an outsized effect on the health of an ecosystem. That being said, all species present in an ecosystem are important, and we should adopt policies that consider many

species, rather than emphasizing a single fish (For more information on ecosystem-based approaches to policy-making, please refer to the first chapter of this report, which focuses on coastal and marine policy.)

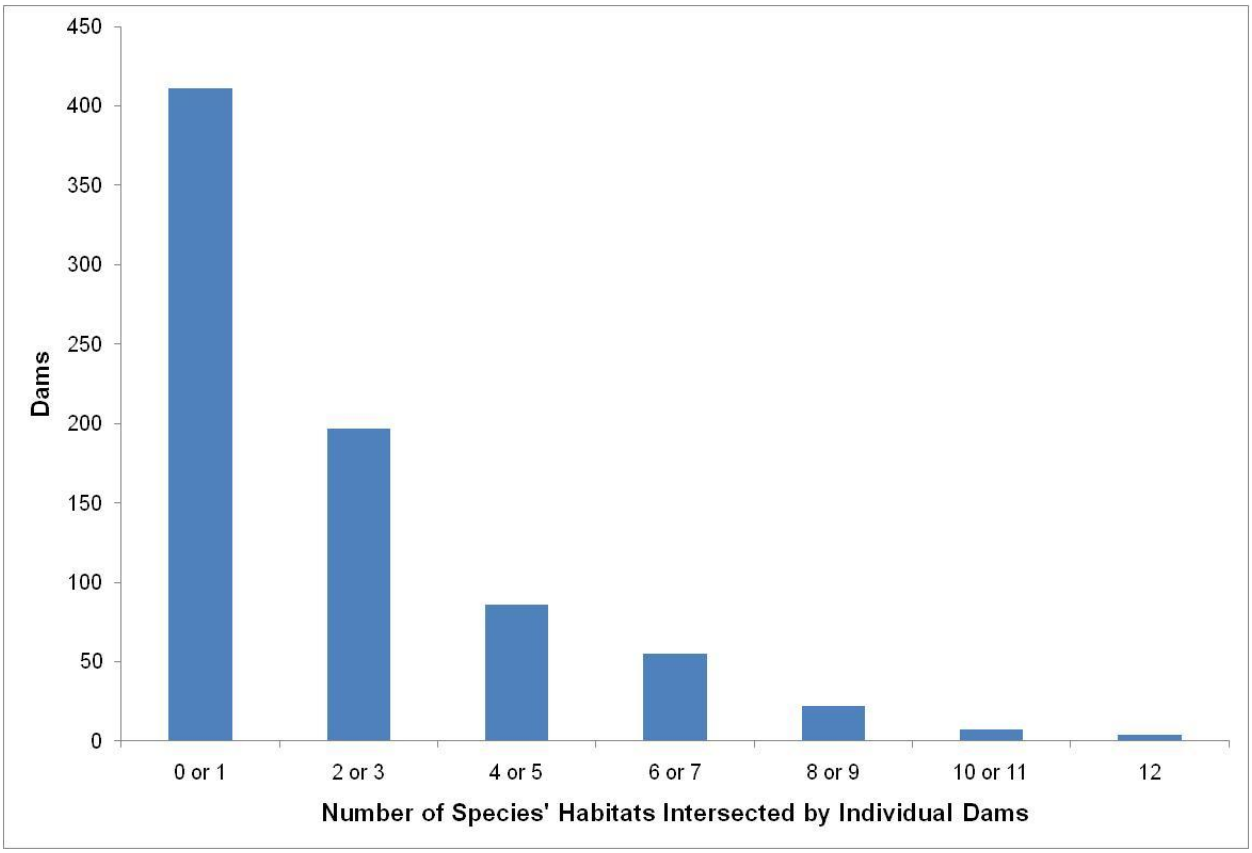


Figure 2.8 Dam-habitat intersections by species (Data Source: GIS Data Catalog - Maine Office of GIS 1987; Maine Office of GIS 2007).

Of the 782 dams we analyzed, 608 (78%) only intersected the habitats of three or fewer species. Eighty-eight dams (11%) were "high intersection" dams, meaning they intersected the habitats of six or more species. Eleven dams (1%) were "very high intersection" dams, meaning they intersected the habitats of more than ten species. Using a list of 23 removed and soon-to-be-removed dams, we determined that two very high intersection dams, the Smelt Hill and Bangor dams, have already been removed, and one very high intersection dam, Veazie Dam, is slated for removal around 2010 or 2011 (Penobscot River Restoration Trust 2005-2009). Seven other removed dams were high intersection dams, and five dams with planned removal are high intersection dams.

Implications

Of all dams either already removed or soon-to-be-removed in Maine, 65% are either high or very high intersection dams. The remaining dams - those which intersect five species' habitats or fewer - comprise only 35% of the group. Out of all dams which still stand (and will stand in the near future), less than 1% can be considered high intersection dams.

What does this say about dam removal in Maine? Dams might be removed for a number of reasons: to achieve conservation goals, for public safety, or to revitalize dormant communities (Bowman 2002). The striking percentage of high intersection dams removed in Maine suggests that migratory fish passage and habitat availability might have been one of the dominant factors influencing dam removal. While other factors - structure age, power generation capacity, federal licensing renewal dates, etc. - influenced the decisions to remove these dams, migratory fish habitat was likely an important consideration.

Scenarios

In the following section we speculate on three possible scenarios for the future of dams in Maine. Scenarios are based on our research on the current state of rivers and dams and other influential factors.

"Cry Me a River": Continue Dam Construction

In an effort to meet growing energy demand with electrical generation from renewable sources, economic and legal incentives would be put in place at the state and federal levels for the construction of new dams. In Maine, where most high-capacity generation sites are already dammed up, small hydropower projects would begin to sprout up on previously free-flowing rivers and tributaries. Concerns about migratory fish habitat would still be voiced, but the state would consider efforts against broader, global climatic change and the potential for economic and developmental rejuvenation in declining mill towns to be more urgent.

This new surge in dam building might resemble the explosion of dams between 1875 and 1900 in Maine: with federal and state incentives to invest in clean-energy projects, dam construction could become a desirable and highly feasible option. Unlike the previous explosion, however, these new dams would generate hydropower exclusively for consumer use. A shift in Maine's electricity portfolio would occur, as hydropower moves onto equal footing with natural gas and other fossil fuels.

"Lazy River": Maintain the Status Quo

A slow process of dam removal would continue. Due to excessively cumbersome permitting and relicensing processes, advocates of dam removal would struggle to meet the necessary criterion and become bogged down in the process. FERC would continue to assert, at an accelerating rate, its ability to deny relicensing based on cost-benefit analysis that includes, among other things, the effects of dams on migratory fish. Owners of hydroelectric facilities would continue to run those dams that remain profitable, but begin to consider selling off older, structurally deficient dams that may cost more in upkeep than they are worth.

Maine's river health would continue to improve, but diadromous fish populations would continue to flounder. Some success stories, like the return of alewives to the Kennebec, would occur occasionally. The general picture, however, would be one of noticeable, but slow progress.

"You Can't Argue With a River": Accelerate Dam Removal, Increase Hydropower Capacity

Following the collaborative example of the Penobscot River Restoration Trust, power companies and dam removal advocates would seek out opportunities to remove high risk and habitat interfering dams while maintaining total hydroelectric generation capacity. Federal subsidies would encourage the implementation of new technology at generation facilities, which, just as the turbine did in the late 19th century, would allow for a significant increase in hydropower capacity. Adding additional turbine generators, installing new more efficient and greater flow capacity turbines, and raising dam heights can significantly increase generation capacity at existing cites (though these processes are difficult, and very expensive) (Clark 2009). These increases could occur at preexisting sites, allowing Maine to meet renewable energy goals without building any new dams.

Fish populations in rivers would return to historic levels. Among these species is the Atlantic Salmon, which could become a success story if it is removed from state and federal endangered species lists. The tourism industry in Maine would be given an added jolt as anglers flocked to the rivers. Maine residents would be relieved of impending safety hazards as old, structurally deficient dams are removed.

Conclusion

Thanks to the efforts of Mainers over the last 30 years, rivers in Maine are healthy and continue to surpass federal water standards. Maine has the

highest percentage of rivers that fully support aquatic life in the nation, and all rivers in the state meet the Clean Water Act's (CWA) fishable-swimmable criteria (EPA 1998; MDEP 2005c).

Dams have played an integral role in Maine's cultural and economic history. Today, 30% of power generated in Maine comes from hydroelectric facilities. Many dams are aging, and have fallen into disrepair. Dams also significantly inhibit diadromous fish migrations. No new dams have been built in Maine since the 1980s, and the current trend is towards removal: 17 dams have been removed since 1986 (Fletcher 2009). Many dams in Maine are licensed by the Federal Energy Regulatory Commission (FERC) and will be up for re-permitting in the next 20 years. In 1994 FERC asserted its authority with the Edwards Dam removal to refuse relicensing based on cost-benefit analyses that include economic, social, cultural, and environmental factors. We should, therefore, be conscious that federally mandated dam removal is a possibility for the future.

Restoring diadromous fish to their historical habitats has been a significant factor in dam removals to date. Based on our analysis, 65% of dams that have been removed or are under consideration for removal can be considered "very high intersection" dams with diadromous fish habitat, while less than 1% of remaining dams fall into the same category. This is extremely pertinent considering the declining populations of diadromous fish. Shortnose sturgeon are at 2% of their historical population and are a listed endangered species, and alewife populations are down 70%. Atlantic salmon and American eels have access to only 10% and 19% of their historic habitats, respectively (Goode 2006).

In the following section we detail our recommendations for the continued management and improvement of the health of Maine's rivers and streams. The recommendations are divided into three groups: river and stream health, fish bypasses, and dam removal.

River and Stream Health

Maine is a leader in river and stream health, and the rest of the U.S. should look to Maine as a model in river conservation. Not only do 99% of the rivers in Maine fully support aquatic life but 99% of them support swimming uses, 99% support fish consumption uses, and 100% support drinking water use (EPA 1998). Since CWA was passed in 1972 vast leaps have been made in river protection in Maine, and the Maine Department of Environmental Protection (DEP) and Maine Department of Marine Resources (DMR) have done an excellent job in river and stream management.

There is some cause for concern. The leading three sources of pollution in Maine's rivers are industrial point sources, agriculture, and hydromodification (EPA 1998). While the amount of pollution from these sources pales in comparison to many other states' problems, it remains an area for worry. As Maine's population grows these pollution sources can only become a larger issue. The DEP has completed a Strategic Plan to focus environmental protection efforts, and we recommend that DEP and DMR continue to coordinate their efforts in the protection of Maine's rivers and streams, focusing some of their resources on point discharges. Treating or removing existing point discharges will require additional funds (Murch 2009), and we recommend that DEP and DMR devote the necessary money to continue to address these site-specific issues. By monitoring these sources of pollution and continuing in their efforts to mitigate the negative effects they have on Maine's rivers and streams, Maine can continue to be the leader in river conservation.

Fish Bypasses

Fish bypasses are becoming increasingly efficient at moving fish upstream and downstream around impassable dams and destructive turbines. Fish passages, especially elevators, are a viable way for the government, dam owners, and environmentalists to work together to mitigate some of the negative effects dams have on diadromous fish. DMR has done an extensive overview of fish passage efforts throughout the state of Maine, creating a report to address hydropower dam fish passage (MDMR 2007). Hydropower dams not only block fish passage but also kill fish when they try to swim through the turbines. Additionally, through the FERC relicensing process described above, one of the conditions of relicensing can be the mandated installation of a fish passage, making hydropower dams significantly easier to construct fish passages on. According to the report, 116 dams are within the historic range of at least one species of diadromous fish. By analyzing the current state of fish passage in each of Maine's watersheds, DMR was able to prioritize which watersheds were high restoration priorities. This is an excellent start.

We recommend DMR take this report a step further. By examining not only hydropower dams but all dams in Maine within diadromous fish habitat, DMR can create a comprehensive effort at fish passage. There are several limitations to comprehensive fish passage in Maine. Fish passage efforts should be part of a broader effort at fish restoration efforts, and we do not recommend one without the other. In some cases, fish passage should not be installed since dams can provide a barrier to the upstream migration of invasive species (Murch 2009). Finally, non-hydropower dams require more effort to find the owner and to enforce fish passage. However, given these

restraints, fish passage is still extremely important to the overall restoration of diadromous fish populations and river ecosystems. We have done a preliminary analysis above, using all the data currently available on all impoundments as well as the most current data on the statewide distribution of the twelve species of diadromous fish in Maine in 2007, although they consider it to still be a "work in progress" (USFWS Gulf of Maine Coastal Program 2007). With the announcement that the Gulf of Maine Coastal program had finished mapping the GIS data for the diadromous fish, USFWS included a sub-heading, "What's next?" Their answer: overlay the map of current dams in Maine with the newly mapped diadromous fish data to prioritize future restoration and fish bypass efforts (USFWS 2007). We have done this and we recommend that DMR consider a similar analysis as ours when examining how best to prioritize all fish bypass and restoration efforts in the future.

Dam Removal

DEP and DMR should emphasize dam removal as a possible river restoration method. River health is excellent throughout the state of Maine, as documented above. However, it can be improved with the removal of dams. Not only will diadromous fish be able to once more return to their historical habitats, boosting spawning grounds and enhancing Maine's depressed fisheries, but overall river health will improve.

First of all, additional research should be done. Less than 5% of all dam removal projects in the U.S. have simultaneous river health and habitat studies (Collins et al 2007). The body of scientific research dealing with dam removal has not been fully explored, and additional studies should be conducted on future dam removal projects. There is no consensus on whether or not dam removal is implicitly good for a river in all cases, and there are some cases where removal is not warranted (such as the threat of invasive species spreading further upstream) (Goode 2009). Continued research should be done to monitor the effect of dam removal and to fully establish all the costs and benefits of the removal process.

Efforts should be made to develop collaborative agreements to address all concerns in dam removal. Comprehensive agreements between power companies, environmental groups and governmental agencies can result in not only environmentally beneficial dam removals but also socially beneficial agreements if power generation is permitted to increase at other dams. By upgrading turbines, generators, or increasing impound height additionally power generation can be achieved without building new dams. While this typically costs millions of dollars, there are currently production tax credits and stimulus funds available from the American Recovery and Reinvestment

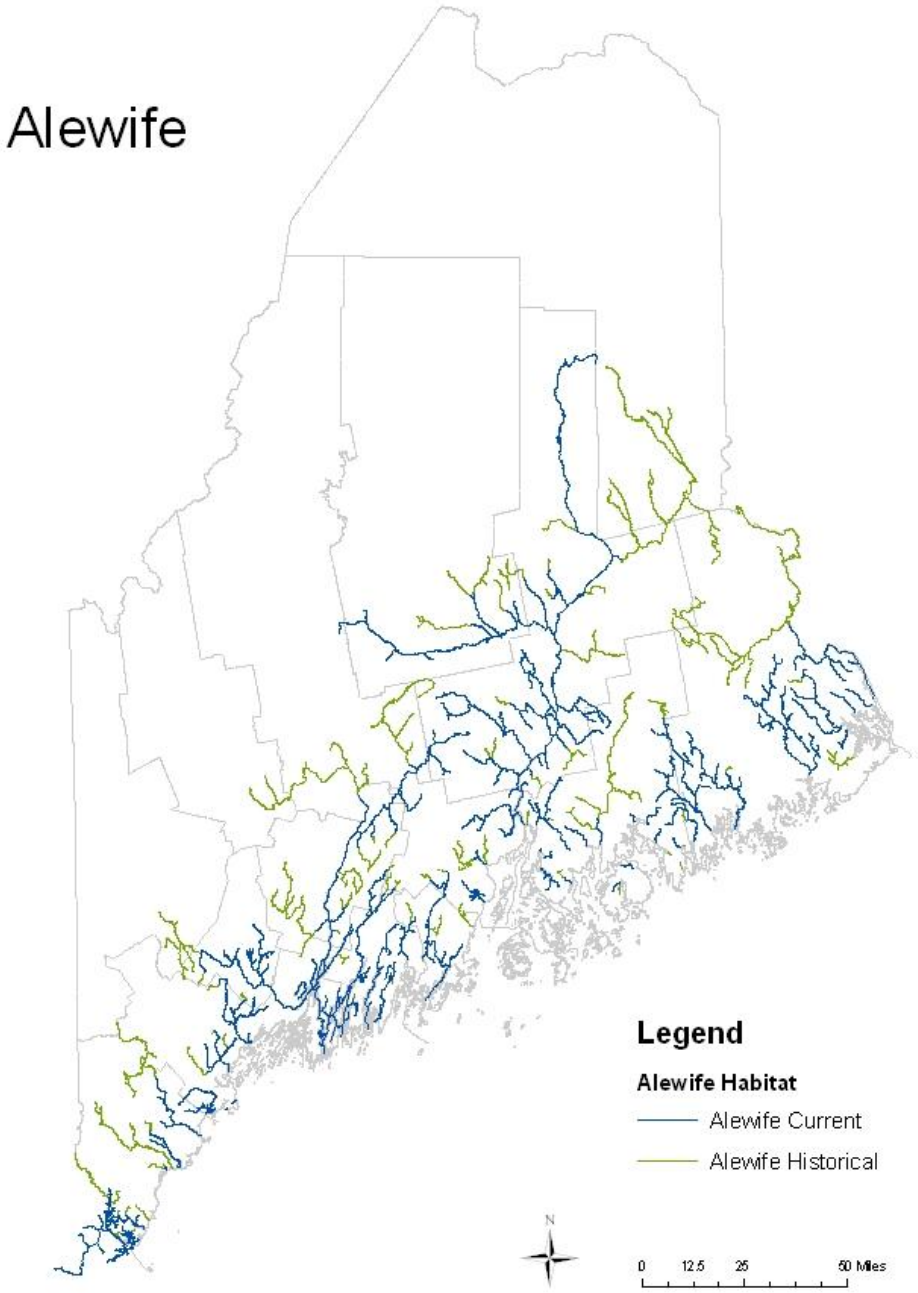
Act of 2009 for certain improvements (Clark 2009). Environmental groups and government agencies should work together with power companies to take advantage of these funds and credits where possible to increase power generation at dams that minimally impact fish populations while removing dams that adversely affect fish migrations.

Many dams in Maine are aging, posing safety concerns for the nearby populace. The Maine Emergency Management Agency (MEMA) has a comprehensive database of potentially hazardous dams, and these dams should be considered for removal. The current dam removal process is the same as the process for dam construction which can involve numerous permits and many years of processing and appeals (Clark 2009; Murch 2009). We recommend that state legislature streamline the dam removal process for extreme cases of public safety. Several states including Wisconsin, Pennsylvania, Ohio, and Connecticut have already created policies to expedite the permitting process involved in dam removal and Maine should follow their lead (Doyle, Stanley et al. 2003).

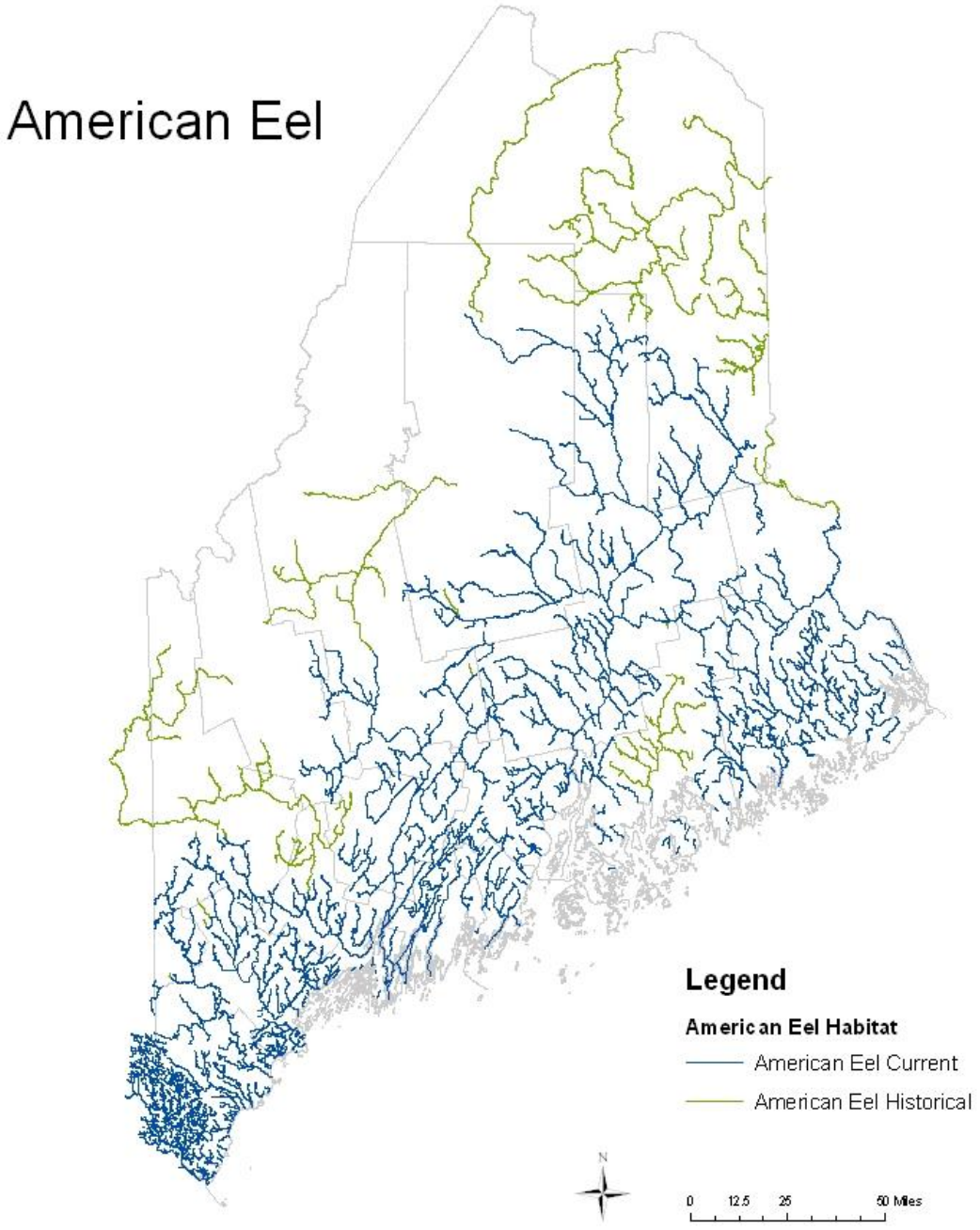
Finally, Maine should dedicate an office to oversee dam issues and dam removal, as Pennsylvania and New Hampshire have done (Gable 2009; Goode 2009). As documented in this report, dam removal is a complex issue fraught with many complications. A dedicated office can comprehensively oversee all dams within the state, working with DEP and DMR to identify dams that significantly harm river health, MEMA to identify safety hazard dams, and the Maine state government and power companies to identify dams that have outlived their usefulness and no longer are needed. By bringing together all this information under one office, Maine can comprehensively examine dam removal as it moves forward into the future.

Appendix A: Current and Historical Diadromous Fish Habitats

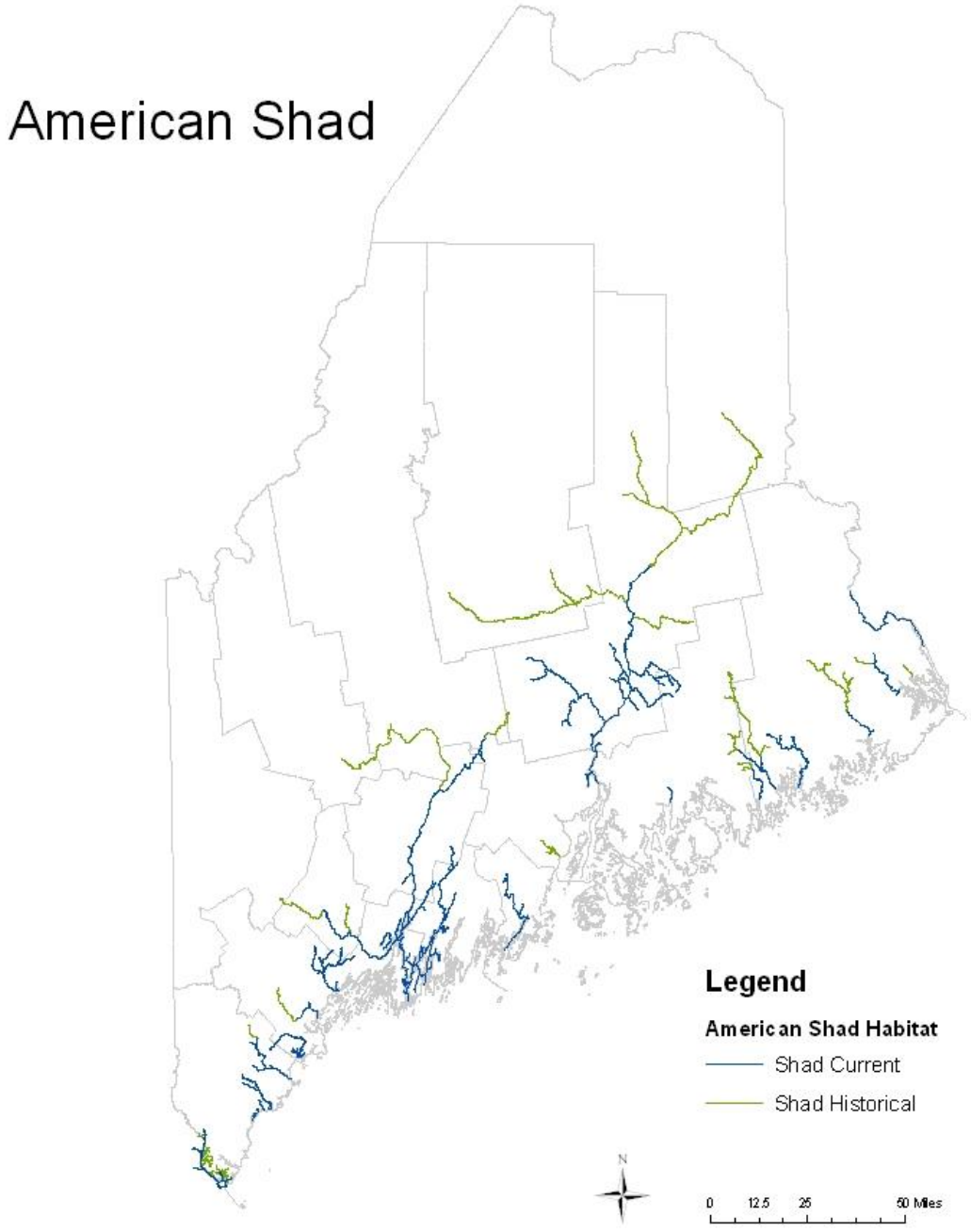
Current and Historical Alewife Habitat:



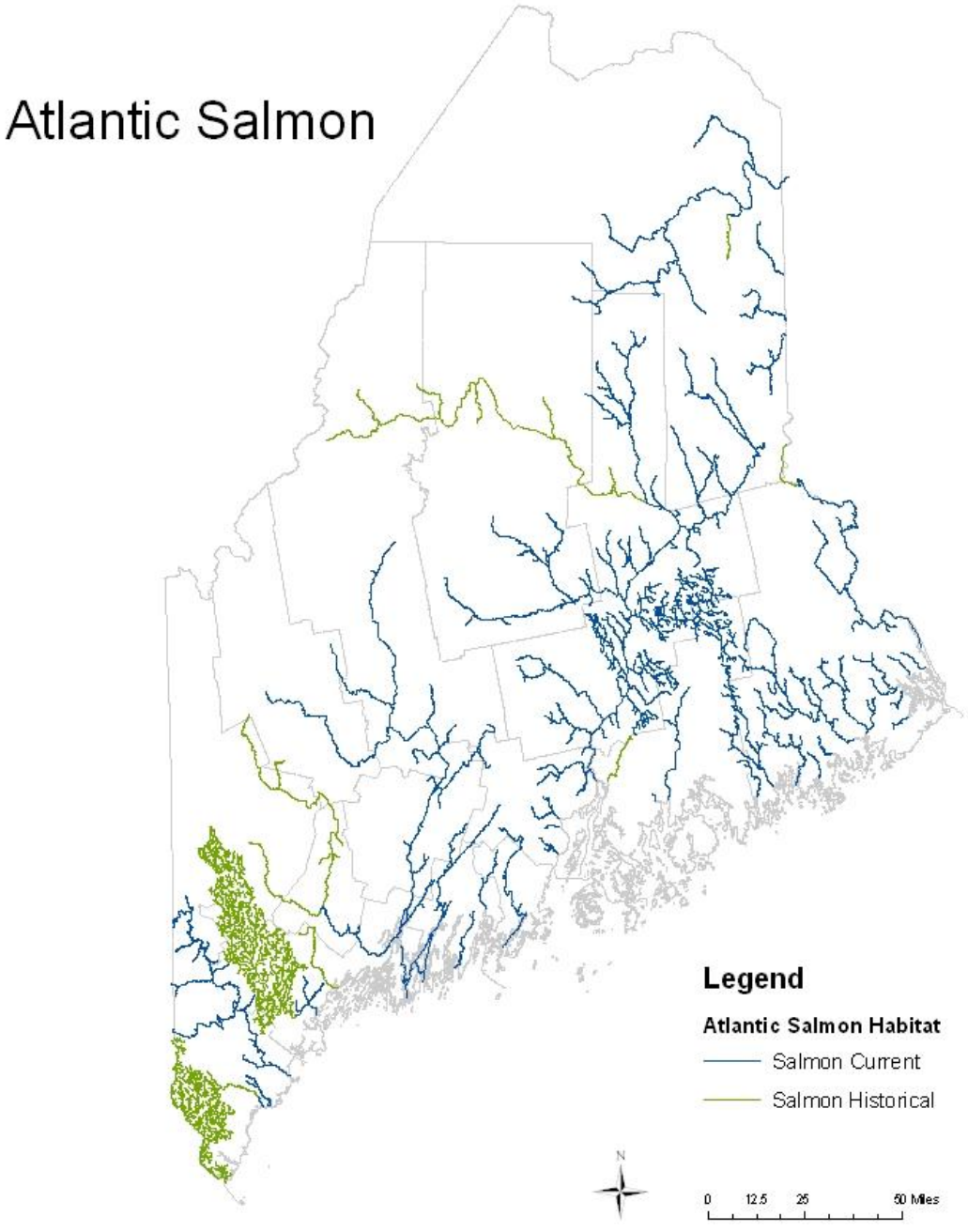
Current and Historical American Eel Habitat:



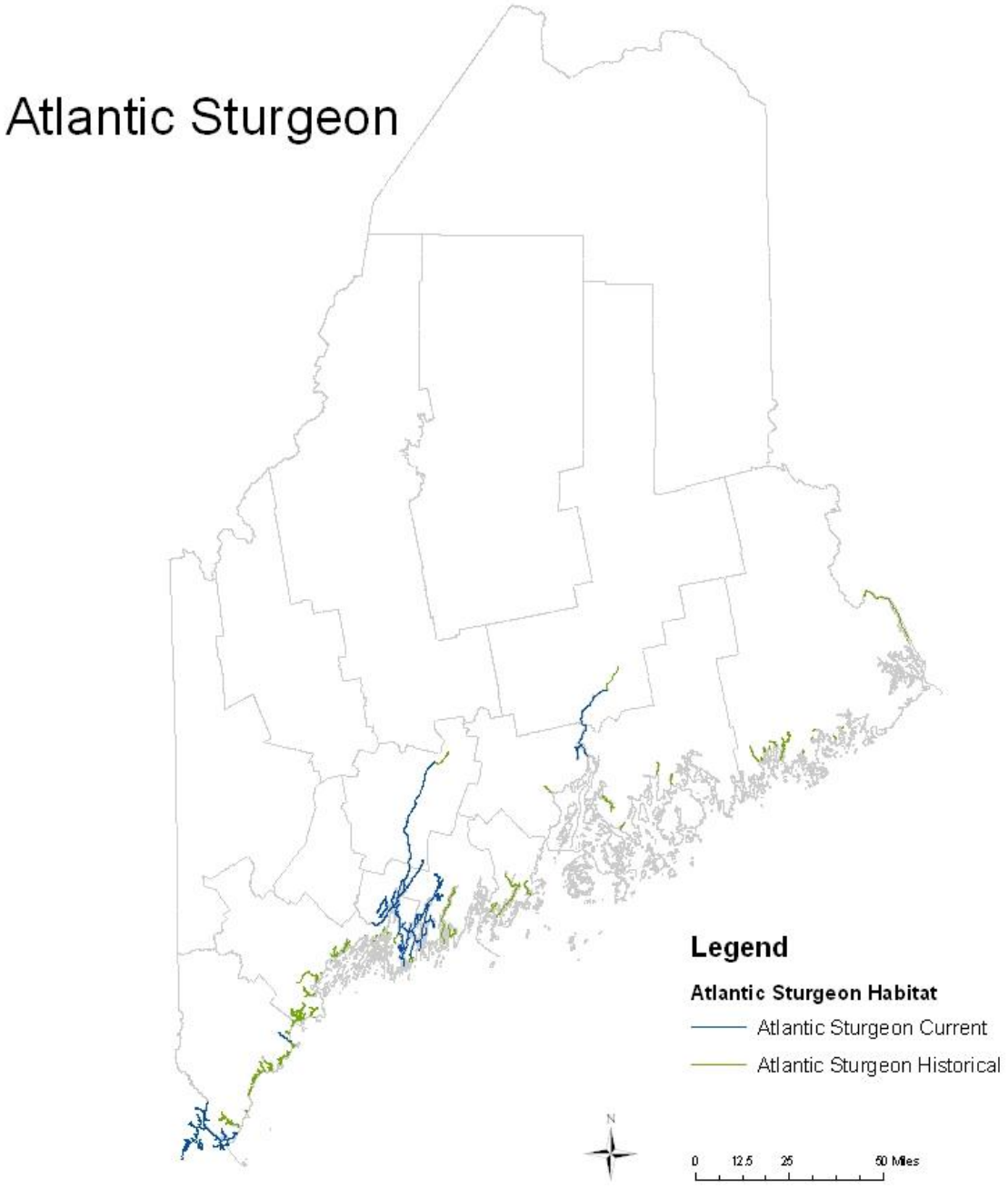
Current and Historical American Shad Habitat:



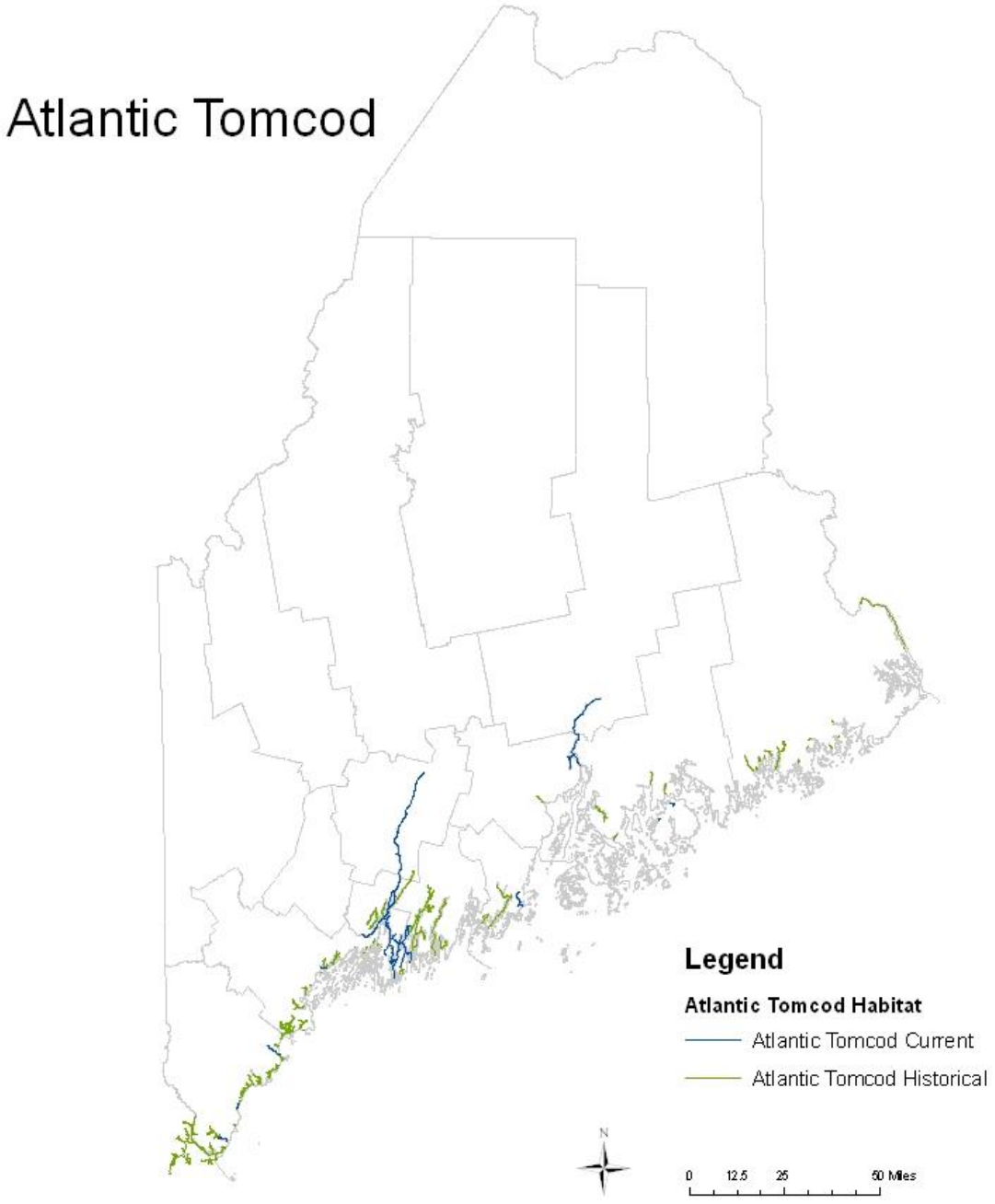
Current and Historical Atlantic Salmon Habitat:



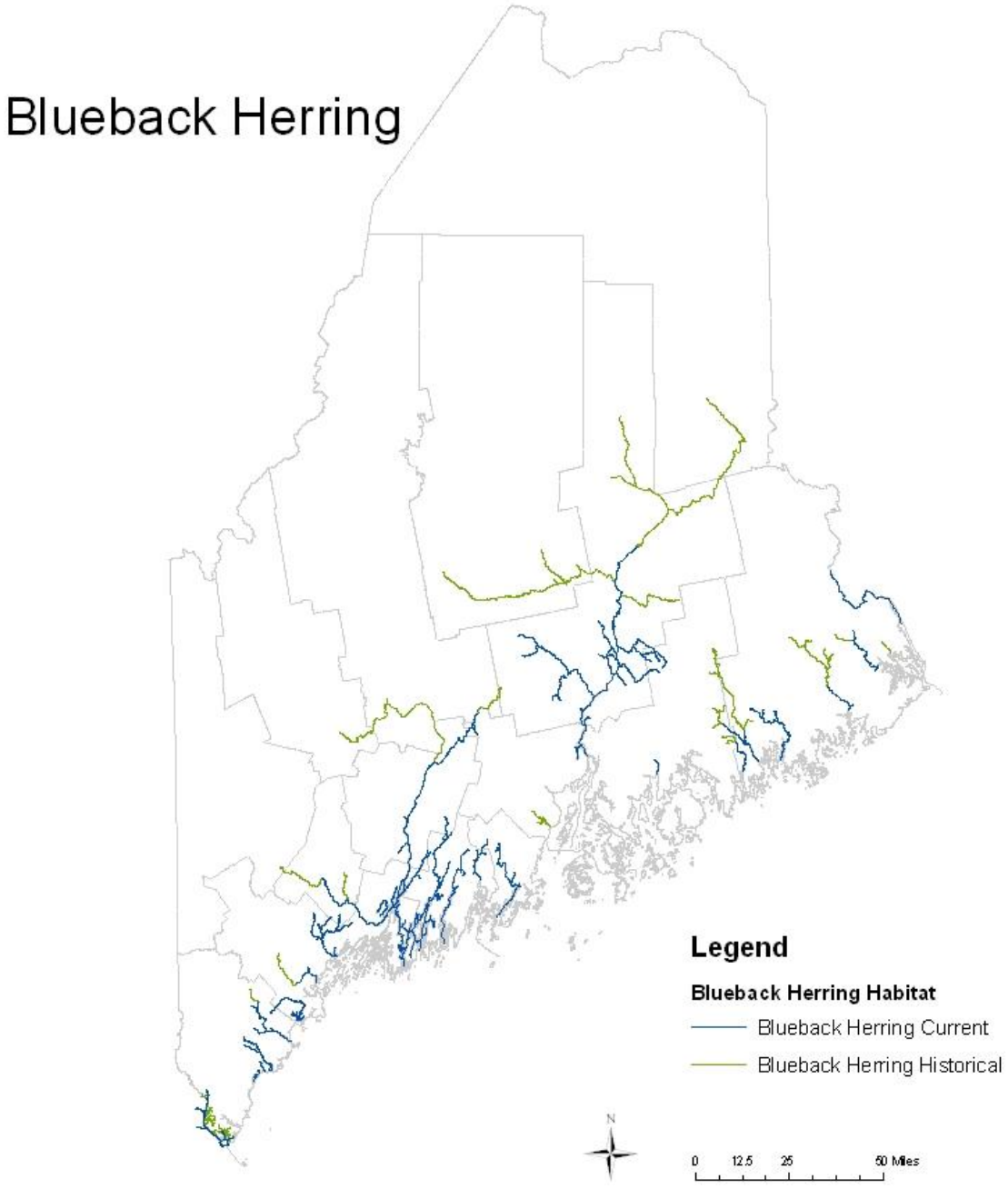
Current and Historical Atlantic Sturgeon Habitat:



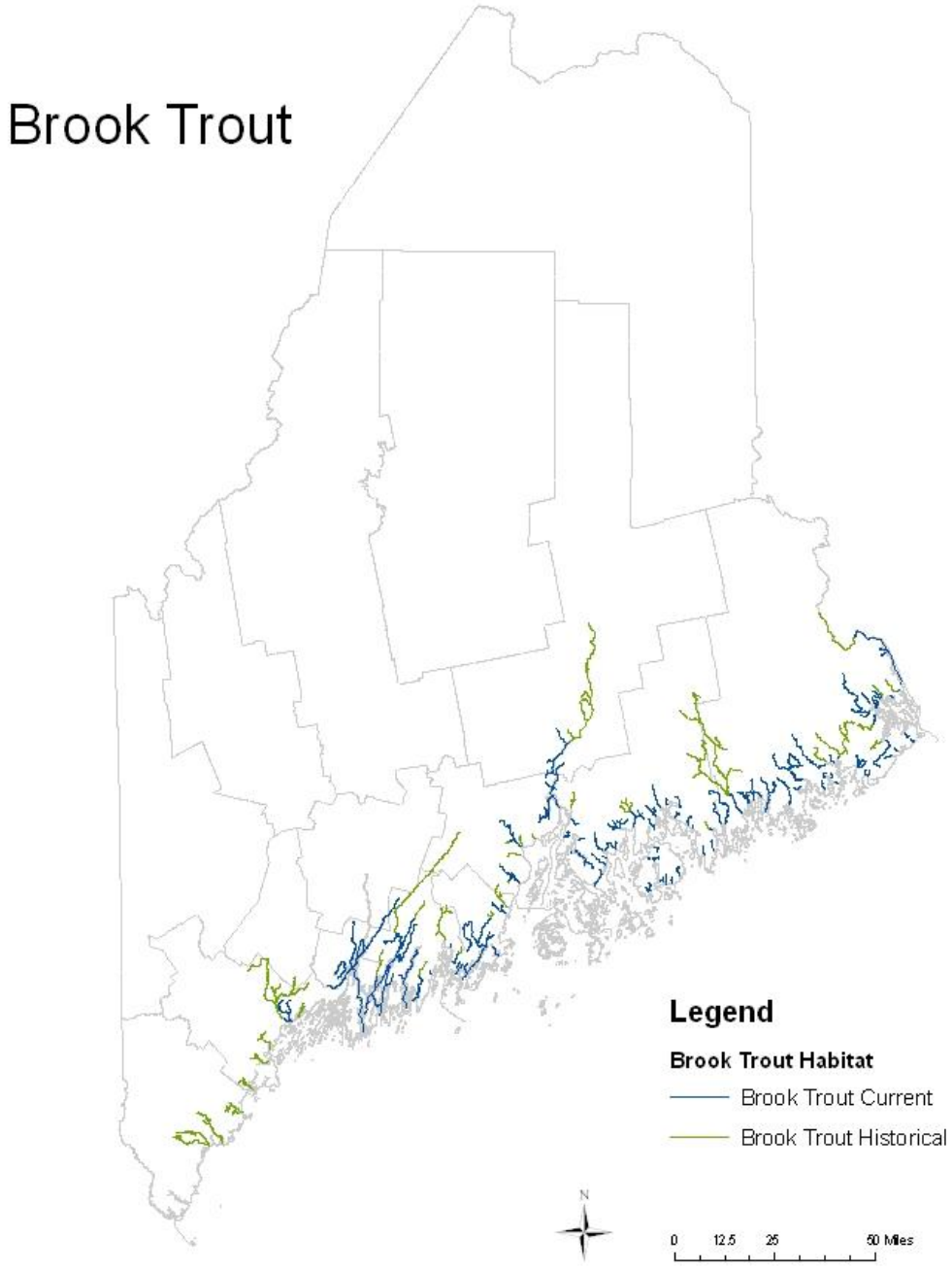
Current and Historical Atlantic Tomcod Habitat:



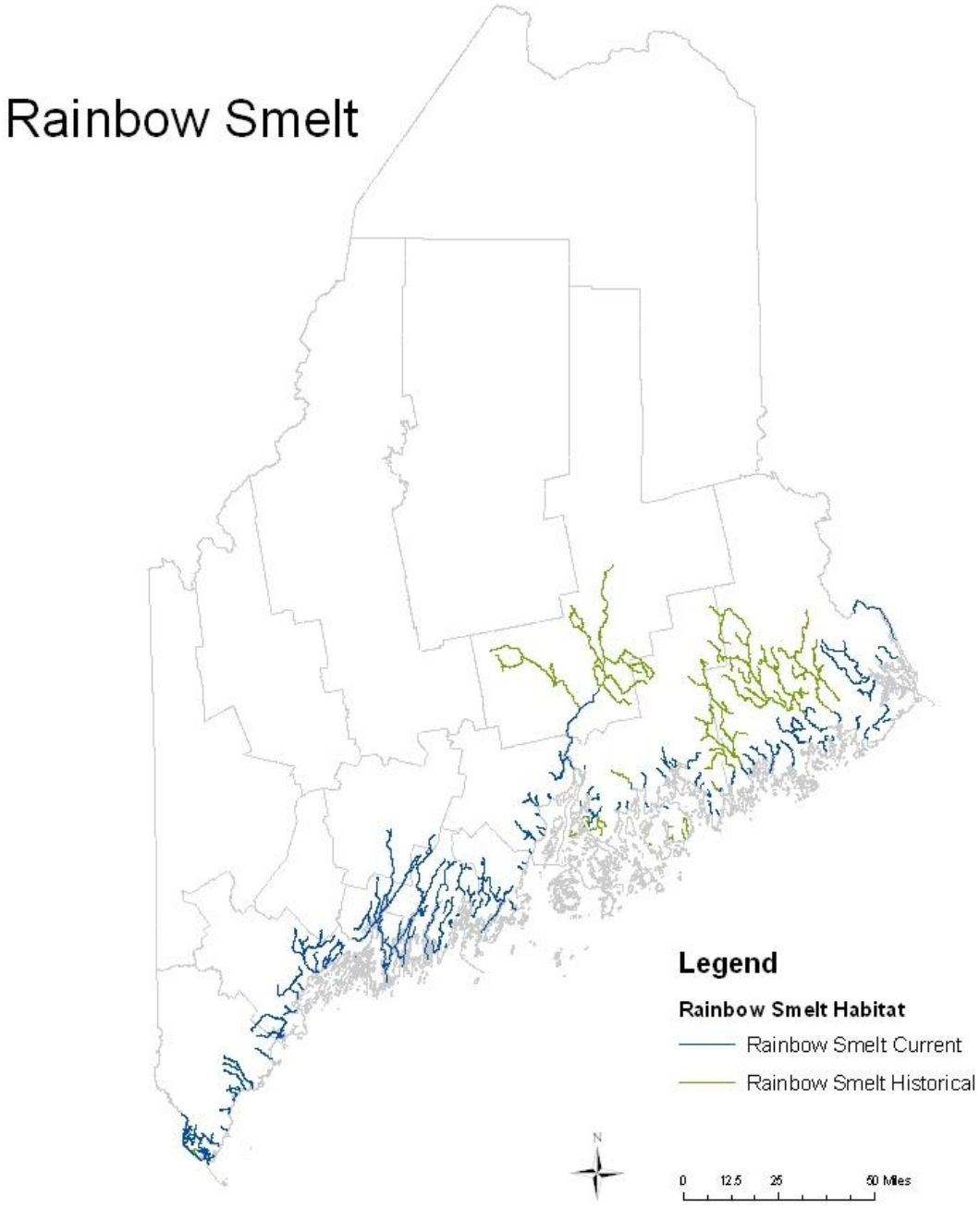
Current and Historical Blueback Herring Habitat:



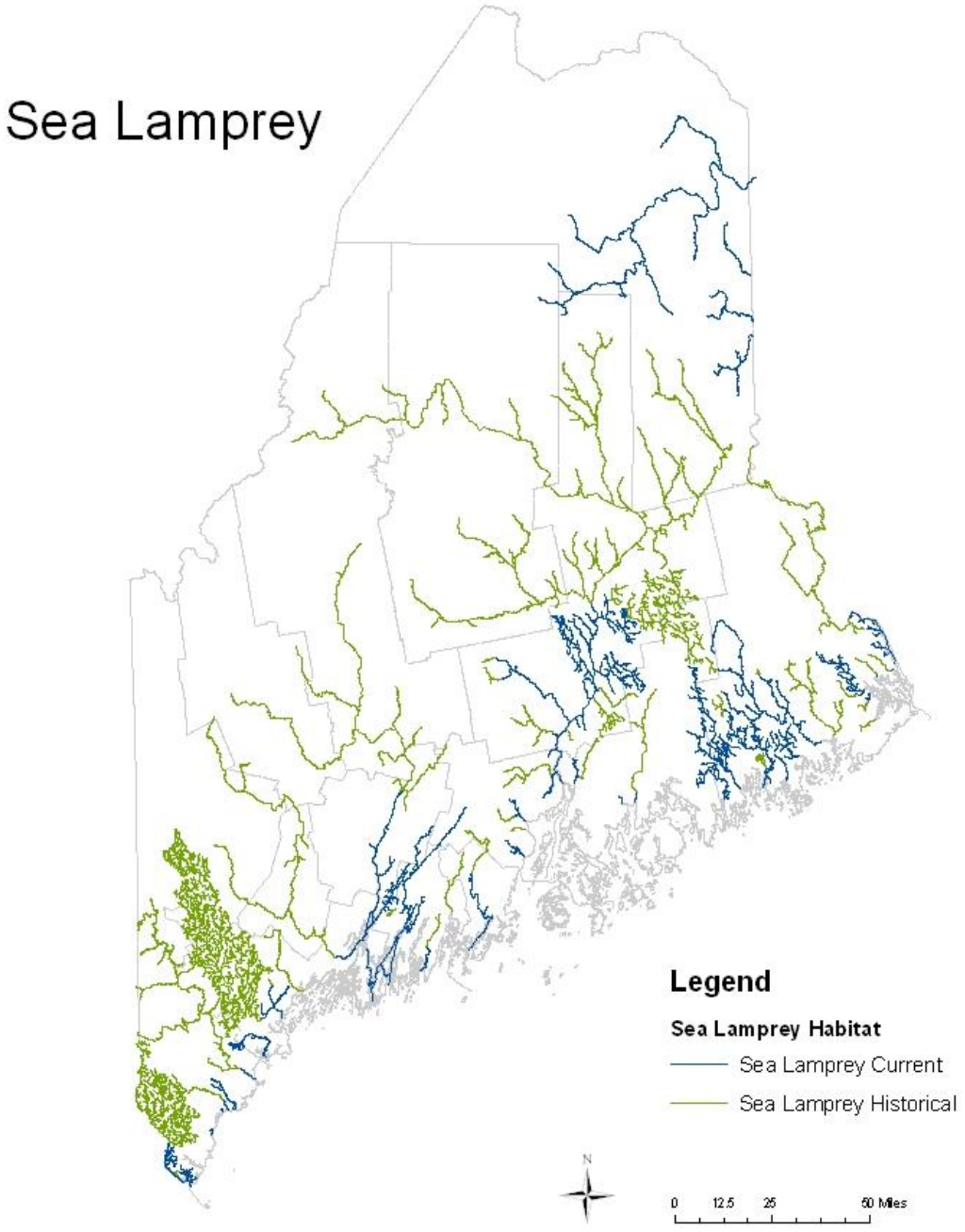
Current and Historical Brook Trout Habitat:



Current and Historical Rainbow Smelt Habitat:

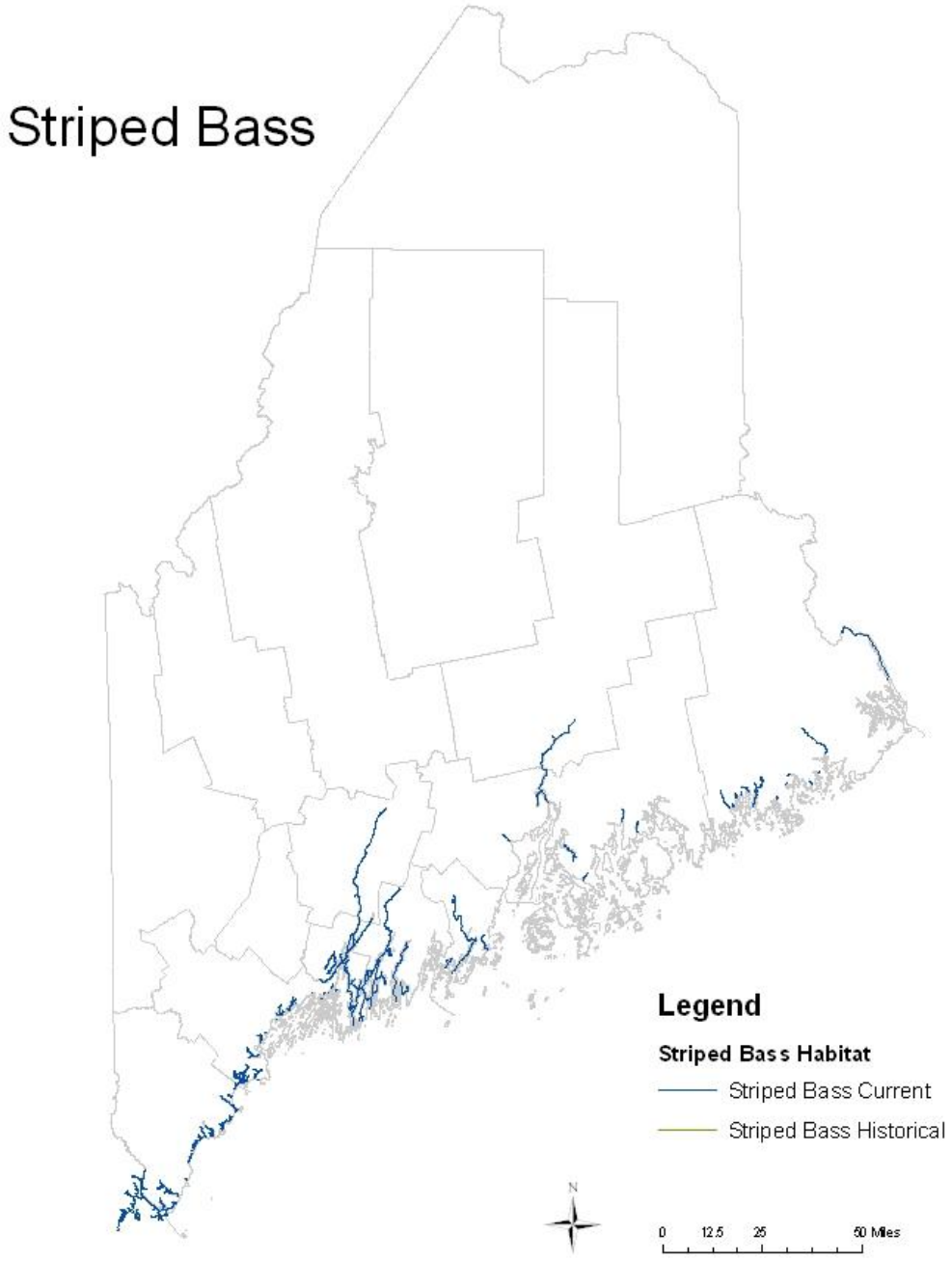


Current and Historical Sea Lamprey Habitat:



Current and Historical Shortnose Sturgeon Habitat:

Current and Historical Striped Bass Habitat:



Source: (U.S. Fish & Wildlife Service 2007)

Works Cited

Advisory Council on Historic Preservation (2002). "The National Historic Preservation Program: Overview." Retrieved October, 2009, from http://www.achp.gov/overview.html.

American Rivers (2002). "The Ecology of Dam Removal." Retrieved November, 2009, from http://www.michigandnr.com/PUBLICATIONS/PDFS/fishing/dams/EcologyofDamRemoval.pdf.

American Rivers (2009). "The 10th Anniversary of the Edwards Dam Removal on Maine's Kennebec River." Retrieved November, 2009, from http://www.americanrivers.org/newsroom/press-releases/2009/the-10th-anniversary-of-the.html.

American Society for Civil Engineers (2008). "Report Card for Maine's Infrastructure: Dams." Retrieved November, 2009, from http://www.maineasce.org/downloads/ReportCard/Final/Maine%20ASCE%20Report%20Card%20Dams%20final%20format.pdf.

American Society for Civil Engineers (2009). "Dams." 2009, from http://www.infrastructurereportcard.org/fact-sheet/dams.

Becker, D. H. (2009). "The Challenges of Dam removal: The history and Lessons of the Condit Dam and Potential Threats From the 2005 federal Power Act Amendments." Retrieved November, 2009, from http://legacy.lclark.edu/org/envtl/objects/36-3_becker.pdf.

Bednarek, A. T. (2001). "Undamming Rivers: A Review of the Ecoloigcal Impacts of Dam Removal." Environmental Management **27**(6): 803-814.

Bowman, M. B. (2002). "Legal Perspectives on Dam Removal." BioScience **52**(8): 739-747.

Clark, C. (2009). Florida Power and Light. Email Interview 11/20/09.

Collins et al, M. (2007). "Stream Barrier Removal Monitoring Guide." Retrieved November, 2009, from www.gulfofmaine.org /streambarrierremoval.

Commonwealth of Massachusetts Riverways Program (2009). "Fact Sheet: Dam Removal Permitting." Retrieved November, 2009, from http://www.mass.gov/dfwele/river/pdf/factsheet_permitting_final.pdf.

Defebaugh, J. E. (1907). History of the Lumber Industry of America. Chicago, The American Lumberman.

Doyle, M. W., E. H. Stanley, et al. (2003). "Dam Removal in the United States: Emerging Needs for Science and Policy." EOS **84**(4): 29-36.

EPA (1998). "National Water Quality Inventory: 1998 Report to Congress." October, 2009, from http://www.epa.gov/305b/98report/.

EPA (2009). "Clean Water Act." Retrieved October, 2009, from http://cfpub.epa.gov/npdes/cwa.cfm?program_id=45.

Federal Energy Regulatory Commission (2009a). "Complete List of Issued Licenses." Retrieved October, 2009, from http://www.ferc.gov/industries/hydropower/gen-info/licensing/issued-licenses.asp.

Federal Energy Regulatory Commission (2009b). "What FERC Does." Retrieved October, 2009, from http://www.ferc.gov/about/ferc-does.asp.

Fletcher, T. (2009). Maine State Dam Inspector. Interview 10/15/09.

Foran, J. (2002). Maine (Guide to American States), Weigl Pub Inc.

Gable, E. (2009). Pa. leads the way in dam removals in 2009. Land Letter, E & E Publishing.

Goode, A. (2006). "The Plight and Outlook for Migratory Fish in the Gulf of Maine." Journal of Contemporary Water Research & Education(134): 23-28.

Goode, A. (2009). Vice President, U.S. Programs, Atlantic Salmon Federation. Interview 09/25/09.

Houston, R. (2009). ME Office of GIS. GIS Specialist. Email Interviews 11/09.

Jungwirth, M., S. Schmutz, et al. (1998). Fish Migration and Fish Bypasses. Oxford, Fishing News Books.

Land Use Regulation Commission (2009). "About the Commission." from http://www.maine.gov/doc/lurc/about.html.

Larinier, M. (2000). Dams and Fish Migration. Toulouse, France, Institut de Mecanique des Fluides.

Lewis, L. Y., C. Bohlen, et al. (2008). "Dams, dam removal, and river restoration: A hedonic property value analysis." Contemporary Economic Policy **26**(2): 175-186.

Maine Department of Inland Fisheries and Wildlife (2007). "Maine Endangered Species Program/Endangered and Threatened Species." from http://www.maine.gov/ifw/wildlife/species/endangered_species/species.htm.

Maine Department of Marine Resources (2008). DMR Review of Statewide Fish Passage Efforts.

Maine Forest Service and Maine Technology Institute (2005). Current Conditions and Factors Influencing the Future of Maine's Forest Products Industry, Innovative Natural Resource Solutions LCC.

Maine Office of GIS (1987). "Impounds." Retrieved October, 2009, from http://megis.maine.gov/catalog/catalog.asp.

Maine Office of GIS (2007). "Diadromous Fish data." Retrieved November, 2009, from http://www.fws.gov/filedownloads/ftp_gis/R5/GOMP/bh/DiadFish/.

Maine Office of Tourism (2008). Tourism Powers Maine's Economy. A Reference Guide to Tourism and the Maine Economy.

Maine Pulp and Paper Association (2009). "About MPPA." Retrieved October, 2009, from http://www.pulpandpaper.org/about_mppa.shtml.

Maine Rivers (2009a). "About Us." Retrieved October, 2009, from http://mainerivers.org/?page_id=2.

Maine Rivers (2009c). "Non-point Source Pollution Program." from http://mainerivers.org/?page_id=77.

MDEP (2005b). "Issue Profile Natural Resources Protection Act (NRPA)." Retrieved October, 2009, from http://www.maine.gov/dep/blwq/docstand/ip-nrpa.htm.

MDEP (2005c). "Classification of Maine Waters." Retrieved October, 2009, from http://www.maine.gov/dep/blwq/docmonitoring/classification/index.htm.

MDEP and Maine Department of Conservation (2009). Regulation of Hydropower in Maine: A Guide to the Maine Rivers Policy and Maine Waterway Development and Conservation Act.

MDEP Bureau of Land & Water Quality. "Dam Removal Permitting Process (brief overview)." Retrieved November, 2009, from http://www.maine.gov/dep/blwq/docstand/removal.htm.

MDEP Bureau of Land & Water Quality (2006). "Percent of Maine Rivers and Streams by Classification." Retrieved October, 2009, from http://www.maine.gov/dep/blwq/docmonitoring/classification/streams_percentage.htm.

MDEP Bureau of Land & Water Quality (2009). "Dam Removal Permitting Process (brief overview)." Retrieved November, 2009, from http://www.maine.gov/dep/blwq/docstand/removal.htm.

MDMR (2007). DMR review of statewide fish passage efforts.

MDMR (2007). "DMR review of statewide fish passage efforts." from http://maine.gov/dmr/searunfish/reports/fishpassagerpt08.pdf.

MRS Title 12 Chapter 200 (1983). Maine's Rivers.

Murch, D. (2009). "Dam Removals in Maine: Status As Of January 1, 2009." Retrieved October, 2009, from http://www.maine.gov/dep/blwq/docstand/dams/non_hydro/dam_removals.pdf.

Murch, D. (2009). Maine DEP. Bureau of Land & Water Quality. E-mail Interview 12/02/09.

Natural Resources Council of Maine (2009). Retrieved October, 2009, from http://www.nrcm.org/default.asp.

Natural Resources Council of Maine (2009). "A Brief History of Edwards Dam." Retrieved October, 2009, from http://www.nrcm.org/historyedwards.asp.

Natural Resources Council of Maine (2009b). "Penobscot River Restoration Project." from http://www.nrcm.org/documents/penobscot_facts.pdf.

NOAA (1996). "Magnuson-Stevens Fishery Conservation and Management Act." from http://www.nmfs.noaa.gov/sfa/magact/.

NOAA (2009). Federal Agencies Protect More Gulf of Maine Atlantic Salmon to Recover Imperiled Stocks.

NOAA (2009b). "Endangered Species Act (ESA)." Retrieved October, 2009, from http://www.nmfs.noaa.gov/pr/laws/esa/.

Northwest Power and Conservation Council (2009). "Fish Transportation." from http://www.nwcouncil.org/history/FishTransportation.asp.

Penobscot River Restoration Trust (2005-2009). "Unprecedented Collaboration." from http://www.penobscotriver.org/content/4030/Unprecedented_Collaboration/ .

Poff, N. L. and D. D. Hart (2002). "How Dams Vary and Why It Matters for the Emerging Science of Dam Removal." BioScience **52**(8): 659-668.

Ragonese, J. (2004). "Fish Passage Effectiveness." Retrieved November, 2009, from www.ferc.gov/EventCalendar/Files/20041018094218-ragonese.pps.

Stanley, E. H. and M. W. Doyle (2003). "Trading off: the ecological effects of dam removal." Ecological Environment **1**(1): 15-22.

State of Maine Public Utilities Commision (2009). "2008 Annual Report." Retrieved November, 2009, from http://www.maine.gov/mpuc/about/annual_report/documents/PUC2008AnnualReport.pdf.

The Maine Council of the Atlantic Salmon Federation (2004-2009). from http://www.mainecouncilasf.org/.

The Nature Conservancy (2009a). "The Penobscot River: A Model Conservation Partnership." from http://www.nature.org/wherewework/northamerica/states/maine/features/art26645.html.

U.S. Army Corps of Engineers (2007). "National Inventory of Dams."

U.S. Army Corps of Engineers (2009). "Mission & Vision." Retrieved October, 2009, from http://www.usace.army.mil/about/Pages/Mission.aspx.

U.S. Department of Energy (2008). "History of Hydropower." Retrieved November, 2009, from http://www.maine.gov/dep/blwq/docstand/dams/non_hydro/dam_removals.pdf.

U.S. Fish and Wildlife Service (1999). "Mission Statement." Retrieved October, 2009, from http://www.fws.gov/policy/npi99_01.html.

U.S. Fish and Wildlife Service (2009a). "Federal Water Pollution Control Act (Clean Water Act)." Retrieved November, 2009, from http://www.fws.gov/laws/lawsdigest/FWATRPO.HTML.

U.S. Fish and Wildlife Service (2009b). "Endangered Species Act of 1973." Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service. Retrieved October, 2009, from http://www.fws.gov/laws/lawsdigest/ESACT.HTML.

U.S. Fish and Wildlife Service (2009c). "Rivers and Harbors Appropriation Act of 1899." Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service. Retrieved October, 2009, from http://www.fws.gov/laws/lawsdigest/riv1899.html.

U.S. Fish and Wildlife Service (2009d). "Federal Power Act." Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service. Retrieved October, 2009, from http://www.fws.gov/laws/lawsdigest/FEDPOWR.HTML.

USC Title 26 § 1101-1112 (2009). American Recovery and Reinvestment Act.

USC Title 33 § 518. 2002 Federal Water Pollution Control Act.

USC Title 42 (1969). National Environmental Policy Act of 1969.

USFWS (2007). "Gulf of Maine Coastal Program Completes GIS Product Displaying Distribution of All 12 Diadromous Fish in Maine." Retrieved November, 2009, from http://www.fws.gov/arsnew/print/print_report.cfm?arskey=21074.

USFWS Gulf of Maine Coastal Program (2007). "Statewide Distribution of Diadromous Fish." Retrieved November, 2009, from http://www.fws.gov/northeast/gulfofmaine/maps_data/diad_fish_mapping.htm.

Wheeler, W. B. and M. J. McDonald (1986). TVA and the Tellico Dam, 1936-1979, University of Tennessee Press.

Wisconsin Valley Improvement Company. "Facts About Hydropower." Retrieved November, 2009, from http://new.wvic.com/index.php?option=com_content&task=view&id=7&Itemid=44.

State of Organic Agriculture in Maine

By Emily Boone and Megan Browning

Executive Summary

The State of Organic Agriculture in Maine 2009 is the third chapter in *The State of Maine's Environment 2009*, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report published since 2004.

We examine trends in overall agriculture and changes in organic production over time in Maine relative to other states, primarily using USDA Census of Agriculture statistics. Additionally, we use a Geographic Information System (GIS) to map locations of organic farms in Maine certified by the Maine Organic Farmers and Gardeners Association (MOFGA). We found that Maine, although a relatively small state in overall agricultural production, is a national leader in organic agricultural production. We examine reasons for this status and discuss future scenarios for organic agriculture in Maine. We also consider benefits and drawbacks of having national organic standards. We conclude that although organic production in Maine requires continued support, Maine policy makers could also promote growth in agriculture by further encouraging local consumption of Maine produced foods. Additionally we recommend that Maine increase efforts to conserve farmland by supporting organic farmers in the state and helping to protect them from development pressures.

Introduction

In the U.S., organic agriculture is one of the fastest growing sectors of the food industry. Once sold and produced only within small niche markets, production and consumption of organic products has been recently increasing at rapid rates. In 1997, the monetary worth of the industry was $3.6 billion; in 2008 it was $21 billion (Greene, Dimitri et al. 2009). Additionally, the U.S. has seen an increase in certified organic acreage, quadrupling in size between 1997 and 2005 from just over one million acres to just over four million acres, and it has continued to grow since then (USDA Economic Research Service 2009). A five-fold increase in federal funding for research and implementation of organic programs in 2008

demonstrates increasing dedication to the industry on a federal level (USDA Economic Research Service 2009).

Defining "Organic"

Organic agriculture is broadly defined as a "locally sustainable, low-input technique for raising crops and livestock" (MOFGA 2009). The International Federation of Organic Agricultural Movements (IFOAM) adds that it "sustains the health of soils, ecosystems and people" and "relies on ecological processes, biodiversity, and cycles adapted to local conditions" (IFOAM 2009). In the U.S., the term "organic" was legally defined in 2002 by the U. S. Department of Agriculture (USDA) with the passage of national organic standards. The USDA definition refers to an organic production system as one that can "respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity" (USDA Economic Research Service 2002). Different stakeholders in organic agriculture have varying interpretations of the definition of organic agriculture; this is a characteristic we explore in our analysis. Whether defined by the legal definition or by other interpretations, on the whole, organic agricultural practices provide environmental and human health benefits by minimizing off-farm inputs.

Environmental benefits of organic agriculture largely result from using ecological methods to maintain soil health. In a nine-year study on soil health, the USDA Agricultural Research Service (ARS) found that using manure as a soil additive was better for building organic matter in the soil than no-till methods commonly used in conventional agriculture that include inorganic nitrogen (USDA Agricultural Research Service 2007). Building organic matter in soil stores carbon, which reduces carbon in the atmosphere and may help to mitigate climate change (USDA Agricultural Research Service 2007). Additionally, organic production methods have the potential to reduce greenhouse gas emissions by reducing the release of nitrous oxide, a bi-product of the oxidation of both inorganic and organic nitrogen sources. Furthermore, by eliminating use of synthetic fertilizers that require abundant energy in the manufacturing process, organic agriculture also reduces energy consumption and helps to conserve finite natural resources (IFOAMb 2009).

Consumers often believe organic foods to be more nutritious than conventionally produced ones, although studies on this are inconclusive (Magkos, Arvaniti et al. 2003). In organic agriculture pests are managed using ecological means, such as natural predators and interruptions in the reproductive cycle, thus eliminating the use of harmful pesticide residues that are commonly found on the products of conventional farms. Animals

raised using organic methods generally have a lower ratio of saturated to unsaturated fat. Additionally, managed appropriately, they often have lower rates of disease than animals raised in feedlots that are supplemented with antibiotics that can be harmful to the environment and human health (IFOAM 2006).

History of Organic Agriculture in the U.S.

Organic agricultural practices existed before the term was even conceived of, simply because modern chemical inputs did not exist. However, the first half of the 20thcentury saw advances in biochemistry and engineering that drastically transformed farming methods. Two chemicals - ammonium nitrate and DDT - helped control disease-carrying insects during WWII and were later employed as pesticides in agricultural production. The widespread use of chemicals and development of new crop varieties, combined with development in machinery resulted in what became known as the Green Revolution. It was not until after the use of chemicals in agriculture that a discussion concerning organic agriculture began to take place.

Paralleling other environmental movements, increased interest in organic agriculture was catalyzed by a series of events that brought awareness about the adverse effects of widely used chemical practices to the general public. In 1962, Rachel Carson published "Silent Spring," an accessible work on the negative effects of DDT and other pesticides on the environment (Kuepper and Gegner 2004). A market for organic foods began to build after J.I. Rodale also helped to popularize the terms, "sustainable" and "organic" agriculture (Kuepper and Gegner 2004). Starting in the 1960s and 1970s as a social movement, the organic idea eventually gained sufficient attention to captivate consumers and larger agro-businesses that saw profit potential in organic markets (Christensen 2009).

Eventually the need arose for national organic standards to unify individual statewide efforts. Under the Organic Foods Production Act of 1990 the USDA established the National Organic Program (NOP), whose goal was to establish national standards for production, handling, and labeling of organic foods. The NOP also developed a system of accreditation for certifiers who would inspect those farms interested in certification and hold them accountable to the national standards. Twelve years later, in 2002, the standards were implemented, and thereafter farms that did not become USDA certified could no longer market their products as organic (USDA Agricultural Marketing Service 2008).

One debate resulting from the establishment of the national organic standards concerned the relative benefits of sustainable versus organic agriculture. Central to the definition of sustainability is environmental stewardship, using resources wisely to ensure their existence for use by future generations. Although many local farms do achieve both sustainable and organic production, the creation of national organic standards resulted in the growth of "industrial organic." Consequently, it became possible for larger scale organic farms to become USDA certified organic despite not necessarily employing sustainable practices since the standards do not directly address sustainability. Large farms, for example, although certified organic, often ship their food longer distances and produce more waste than smaller farms, both factors that decrease the sustainability of the farm. USDA organic certification also drew attention away from local consumption by making it possible to purchase certified organic food that was not produced locally. Local agriculture is also beneficial for the environment and human health because it eliminates extensive transportation of food and emissions for vehicles used for transportation. Sustainable, local, and organic agriculture all have advantages and disadvantages, and opinions on the relative significance of each practice vary among stakeholders.

History of Organic Agriculture in Maine

From the early stages of settlement, agriculture and timber were the primary industries driving the Maine economy. However, short growing seasons, rocky soil, and distance from markets ultimately prohibited the profitability of Maine agriculture. As a result, populations of farming communities peaked in the 1850s and declined steadily thereafter (Palmer, G. et al. 1992). Throughout the 19th century, better agricultural conditions in the West pulled populations westward, and the presence of agriculture in Maine deferred to other industries (Darling, Hansen et al. 2007). Timber companies and paper mills exploited the wealth of forest resources. Tourism developed throughout the turn of the century as a source of income for the state (Palmer, G. et al. 1992). Over time these development mechanisms resulted in land use changes and altered population distributions, ultimately leading to suburban and urban development pressures on previously agricultural land.

In Maine, remaining farms were challenged to compete with industrial, conventional farms in the West and Midwest, and a need arose to develop a distinctive market. This spurred early growth of the organic agriculture movement in Maine. In 1971, years ahead of the establishment of national organic standards, a group of Maine farmers started an association of organic farmers and gardeners, MOFGA, that currently claims to be "the oldest and largest state organic organization in the country" (MOFGA 2009).

In 1972, MOFGA began a system of certifying farms as organic based on the Rodale Organic Garden certification guidelines, thirty years before the U.S. government took interest and created national organic certification standards (MOFGAb 2009). Today MOFGA has a separate Limited Liability Corporation (LLC) in charge of certification that is accredited by USDA (MOFGAb 2009). In addition to certification, MOFGA provides several resources for Maine organic farmers, including technical assistance and education about growing organically and publication of monthly organic price reports. They also host an annual Common Ground County Fair that aims to raise awareness and educate about organic and local food in Maine.

Partly resulting from the existence and strength of MOFGA as an organization, organic agriculture is a topic relevant to Maine. As Maine's economy continues to shift away from historically strong industries, organic agriculture may contribute positively to the state in both environmental and economic terms.

Goals and Objectives

In this chapter we assess the status of organic agriculture in Maine and its implications for economic and sustainable development for the state. We examine historical trends in Maine's agriculture in order to identify trends in the growth of organic production. In doing so we compare Maine to other states in the U.S. as well as other states in New England. The following questions are central to our evaluation of organic food in Maine: How can agriculture in Maine be characterized? What is the state of organic food production in Maine? What is the state of demand for organic food? How does Maine's agricultural production, and specifically organic agricultural production, compare to other New England States and to the country as a whole? What are the impacts of these trends on Maine's economy and environment? Following our presentation of agricultural trends and the resulting implications, we propose possible scenarios for the future of organic agriculture in Maine and provide specific recommendations for continuing growth based on our research.

Methods

In order to best assess the state of organic agriculture in Maine we used both quantitative and qualitative methods of analysis. We conducted 12 semi-structured interviews with farmers, policy makers, and administrators to assess opinions and outlooks from stakeholders in Maine (Appendix A). After these discussions, we identified trends in the topics and opinions discussed in order to guide our research. We also conducted a thorough literature review of relevant studies and publications about agriculture in the

U.S. and specifically the organic sector to identify the current trends and status of organic agriculture in Maine. We reviewed both books and online publications to gather information about agriculture and specifically organic agriculture.

We gathered quantitative data about conventional and organic agriculture in the U.S. from the USDA Economic Research Service (ERS) and USDA Census of Agriculture. We used these data to compare Maine agricultural trends with those in other U.S. states. The USDA website also provided information about federal laws governing agriculture. We gathered Maine specific data from the Maine Organic Farmers and Gardeners Association (MOFGA).

We estimated the number of organic farms using the number of farms certified organic by USDA accredited certifiers. Data obtained on certified farms before the existence of national standards were considered organic under varying state standards that differed from the federal standards outlined in the NOP.

Our analysis also included creating maps of all the current MOFGA certified organic farms. We used a Geographic Information System (GIS) to visually represent and to analyze our farm data. We obtained data from the Maine Office of GIS on roads and boundaries, the U.S. Census Bureau on population density, and MOFGA on the street addresses of organic certified farms in Maine. We used ArcGIS software (ESRI 2009) and to geocode the location of farms to create a map of Maine with a point on each farm. We were able to match 313 of the 358 given addresses of certified organic farms in Maine with a point on the map. Those addresses that remain unmatched were incomplete in the database provided by MOFGA or unrecognizable by GIS.

We calculated the number of certified organic farms in each county by using GIS to calculate the frequency of farms per county. We then used data from the 2007 USDA Census of Agriculture to determine the total number of farms in each county. We estimated the number of conventional farms in each county by subtracting the number of certified organic farms from the total number of farms in each county. The 2009 count for the number of MOFGA certified farms was 382. The location data we were given only contained 358 certified organic farms in Maine, and the map we used only located 313, or 87% of these. Thus in our calculations we used 313 as the estimated number of certified organic farms in Maine. We assume this is a reasonable approximation because the 23% of farms that were not geolocated were likely to follow a similar distribution.

Legislation

Federal Legislation

Key federal legislation related to organic agriculture is outlined in Table 3.1. Several laws exist related to pesticide use and food safety. Those laws most directly affecting the organic industry are the 2008 Farm Bill, and the 1990 Organic Foods Production Act, which gave way to the National Organic Program (NOP) establishing national organic standards.

Table 3.1 Federal laws influencing organic agriculture in Maine

Law	Year	Description	Location
Federal Insecticide Fungicide and Rodenticide Act	1972	Mandated that the EPA regulate pesticide use for the protection of human health and the environment	USC Title 7 § 136
Organic Foods Production Act	1990	Mandated the creation of the National Organic Program (NOP) and the passage of uniform organic standards	USC Title 7 § 6501
Food Quality Protection Act	1996	Amended FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA) by including stricter safety standards and a complete reassessment of all existing pesticide tolerances	USC Title 7 § 136
Federal Food, Drug, and Cosmetic Act	2002	US Food and Drug Administration are granted the authority to oversee safety of food, drugs and cosmetics. A 2002 amendment authorizes the EPA to set tolerances, in the form of maximum residue limits, on all pesticides	USC Title 21 § 301
Farm Bill	2008	Overarching regulation on agriculture in the U.S. including regulations on subsidies and crop insurance	USC Title 7 § 8701

In the late 1990s as demand for organic products grew, a need arose for national organic standards. As a part of the 1990 Farm Bill, the Organic Foods Production Act that included the National Organic Program (NOP) was passed. The goal of the NOP was to set national standards for organic production. Twelve years later in 2002, the NOP rule was issued establishing uniform national standards for organic goods including production and handling standards, labeling standards, and a system of USDA accreditation for independent certifiers (USDA Agricultural Marketing Service 2008).

In addition to the NOP, growth in the organic industry has been reflected in several changes in federal law most recently represented in the 2008 Farm Bill, also known as the Food Conservation and Energy Act. Most notable was the addition of a section specifically addressing organic production, Title X: Horticulture and Organic Agriculture. However, several changes were made in other sections that directly influence organic growing practices (USDA Economic Research Service b 2009). Generally these changes increase funding for research on organic production and transition to organic production. They also include organic operations as eligible for several existing programs. One notable increase was for the National Organic Certification Cost Share Program, which provides subsidies to farmers for the certification fee. In 2008, this subsidy increased to $750 per farm, up from $500 per farm in 2002 (USDA Economic Research Service b 2009). (See Appendix B for a complete list of sections relating to organic agriculture in the 2008 Farm Bill.)

State Legislation

Maine dedicates only a small amount of its budget to the Department of Environmental Protection (DEP), and this amount decreased between 2004 and 2007. Out of a total 2007 state budget of almost $3 billion, only $6 million was spent on the DEP, representing only 0.2% of the total. Greater amounts were put into the Department of Labor, the Department of Economic and Community Development, and the Department of Conservation. All of these departments have an effect on agriculture in the state, but education and health took the greatest percentage, almost 80% between 2006 and 2007, of the overall state budget (The Brookings Institution 2006). Although health and education are priorities, such an extreme difference in funding available for health and education in Maine put other sectors at a disadvantage.

Table 3.2 below outlines specific state programs that concern organic agriculture. A diverse range of state laws address issues related to organic agriculture in Maine, including chemical use, distributors, and consumer information.

Table 3.2 State legislation influencing organic agriculture in Maine

Law	Year	Description	Location
Maine Pesticide Control Act of 1975	1975	Products controlled due to suspicion of tainting by pesticides; gives authority to Board of Pesticides Control to regulate pesticides in Maine	MRS Title 7 § 601-625
Commission To Study the Protection of Farms and Farmland	1975; amended 1990	Requires that the valuation of farmland enrolled in the program be based on the current use for agricultural or horticultural purposes, and cannot reflect development values, or attributes such as road frontage or shore frontage	MRS Title 36 § 1101-1121
Land for Maine's Future Program	1987	Provides state funding to purchase land and easements for conservation. Prioritizes land with multiple benefits or unique values and allowing motorized public access	MRS Title 5 § 6200-6211
Brands, Labels and Trademarks; revocation	1989	The Maine Department of Agriculture registered the voluntary Maine Quality Trademark	MRS Title 7 § 443-B
Maine's Nutrient Management Act	1989; supplements 1999	Established requirements for Nutrient Management Plans and Livestock Operations Permits for qualifying farms. Owners or operators of a qualifying farm are required to have and implement a Nutrient Management Plan pursuant to Maine Department of Agriculture, Food, and Rural Resource (DOA) guidelines	MRS Title 7 § 4201-4214

Farmer's Market Definition and Prohibitions	Definition 1993, prohibitions 2005	Provided definition of farmer's market	MRS Title 7 § 415
Board of Pesticides Control	1997	Called for plan to minimize pesticides and gives authority to the Board of Pesticides Control for regulation	MRS Title 22 § 1471-A to Z
Voluntary Municipal Farm Support Act	2007	Allows municipalities to compensate farmers the full value of their property taxes if they receive a conservation easement being non-agricultural development for at least 20 years	MRS Title 7 § 60-60-A
Failure to Adopt Best Management Practices	2007	Farm not practicing best management practices may be subject to abatement costs by the Attorney General and fines for civil violation	MRS Title 7 § 158
Educational outreach	2007	Educational outreach program for the agricultural community to increase awareness of new legislation and the complaint resolution process related to preservation and protection of agricultural and natural resources	MRS Title 7 § 160
Maine Agriculture Protection Act	2007	Established a Commission to Study the Protection of Farms and Farmland in Maine; Amendments in 2009 implement the recommendations of the Commission to Study the Protection of Farms and Farmland, including "farming for Maine" farms; monitors estate tax changes; establishes district program under Commissioner of Agriculture; requires proposed subdivision under MSPO include a map of farmland parcels of five acres or more	MRS Title 7 § 151-163

MOFGA has historically been an influential advocate for the state in terms of policies promoting organic agriculture. In 1997, two Maine state senators represented MOFGA by proposing "An Act to Reduce Reliance on Pesticides" which was passed by the Maine Legislature. The act required all branches of government to minimize reliance on pesticides and called for a system of recording and reporting pesticide sales. In 1998, the Maine Board of Pesticides Control, backed by MOFGA, denied an application to market corn grown with the pesticide Bacillus thuringiensis (Bt), making Maine the only state in the U.S. to prohibit this product (MOFGAc 2009).

Organic food is free of genetically modified material, and organic crops are required to be isolated from non-organic ones. In 1993, the Maine state legislature created the Maine Commission to Study Biotechnology and Genetic Engineering in response to the MOFGA proposed legislation to label genetically engineered foods. Though the legislation was a compromise to MOFGA's proposal, the initiative by MOFGA was the first legislative state initiative in the U.S. to propose mandatory labeling of GE foods (Get Free Maine 2007).

Several state programs have sought to protect farmers from pressure to sell or develop their land. In 1975, the Farm & Open Space Laws provided property tax relief for agricultural land. Additionally, programs such as Land for Maine's Future have supported conservation projects and provided funding to programs that maintain farmland. The Maine Farms for the Future program provides business planning assistance, grants, and financing for growing agricultural enterprises (Maine Farms for the Future).

In 2008, the Maine legislature created the Commission to Study the Protection of Farms and Farmland in Maine. Recent Maine state legislation implemented a number of recommendations provided by the Commission. In 2009, four steps were implemented, which turned recommendations into law.

The Commission to Study the Protection of Farms and Farmland in Maine provides the Commissioner of Agriculture the authority to design and implement a pilot agricultural program examining the effectiveness of agricultural districts in keeping farmland in agricultural production. The legislation also establishes a "Farming for Maine" program, which publicly registers local farms and builds awareness and education about land use plans and decisions. Furthermore, the Act enables the Commissioner of Agriculture and the State Tax Assessor to assess the impact of estate tax changes have had on the state farmland base. Lastly, the Act defines

"farmland" and requires that land use decisions through the Executive Department, State Planning Office, Department of Agriculture, and Food and Rural Resources identify farmland on maps and consider municipal programs intended to protect farmland.

Stakeholders

A variety of stakeholders play a role in organic agriculture including both national and state government agencies, as well as organic certification companies, interest groups, and a large variety of producers, suppliers, and consumers of organic goods.

Government

All agriculture in the U.S., both organic and non-organic, is governed by The U.S. Department of Agriculture (USDA). This agency not only implements policy to regulate farming practices in the U.S., but it conducts a census of agriculture to keep track of developments over time. The USDA developed national standards for organic production, handling, and labeling, as well as a program to accredit independent certifiers. The Environmental Protection Agency (EPA) is another federal agency that influences agricultural policy through recommendations, policy briefs, and chemical research. Additional federal research funding through land grant institutions and the Organic Farming Research Foundation contribute to the impact of policies and agricultural methods. Other federal department stakeholders, in addition to the USDA, include the Food and Drug Administration, the U.S. Department of Health and Human Services, and the U.S. Center for Disease Control for the impacts of pesticides on health.

State government agencies in Maine that have a stake in organic agriculture include the Maine Department of Agriculture, the Maine Department of Environmental Protection, and the Maine Board of Pesticides Control. Each of these agencies enforces federal policy and also implements policy to regulate agricultural practices, and pesticide usage within Maine.

Certifiers

In order to label products organic, farmers must obtain organic certification. Nationwide, a variety of USDA accredited independent certifying companies exist to grant such certification based on a strict set of criteria about the land and the agricultural practices in use there. The Maine Organic Farmers and Gardeners Association (MOFGA) is the most prominent stakeholder in organic agriculture in Maine. In addition to being the primary USDA accredited organic certifier, MOFGA provides information and technical

assistance to organic farmers throughout Maine. MOFGA also works to promote local, organic food each year through their annual Common Ground Fair. Additionally, MOFGA advocates for implementation and adjustment of public policy related to organic agriculture (MOFGAd 2009).

Interest Groups and Associations

Worldwide, there appears to be growing interest in organic agriculture, as is demonstrated by the number of interest groups advocating organic agriculture. The International Federation of Organic Agriculture Movements (IFOAM) unites organic agricultural movements around the world. Several national associations have a similar mission within the U.S. including the National Organic Coalition and the National Association of State Organic Programs, both of which work to support and promote organic agriculture across the U.S. In addition, similar to MOFGA in Maine, many states have state wide associations in place to facilitate organic agricultural practices by providing support and information to farmers and educating others about organic farming. Such a group in New England is The Northeast Organic Farming Association (NOFA), which is comprised of chapters for each Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. The Maine Farm Bureau, a non-governmental group, non-profit organization, lobbies for policies pertinent to agriculture and rural life. Other entities, such as the Down East Business Alliance, provide education and assistance to farmers and farmers' market managers.

Processors and Distributors

Farm products often need processing, especially livestock and dairy, in order to add economic value before being sold. Distributors are also necessary for making agricultural products more easily and available and accessible on larger scales than farmers markets where farmers sell their food directly to the consumer.

Producers, Suppliers, and Consumers

The producers, suppliers and consumers are arguably the most important groups of stakeholders. All farmers, both organic and non-organic, play a role in the state of agriculture. Most sell their products at farmer's markets. The presence of farmer's markets can revitalize towns and cities, bringing locally grown food to people in the neighboring communities. Restaurants are another supplier that creates a market for organic food. The city of Portland, for example, is home to several restaurants that prepare organic goods. Larger suppliers, such as supermarket chains Hannaford and Shaws also supply goods obtained from farms. Additionally, stores like Whole Foods

play a role in promoting locally grown, organic products. Lastly, those who buy the products from farms, whether at a farmer's Market or in a restaurant, play a large role because it is the buying habits of consumers that help to determine such important factors as supply, demand, price and cost. These factors ultimately affect what farmers grow and how they grow it. "Consumers" includes both residents of the community in which the organics are grown, as well as visitors and tourists, especially in a place like Maine, who create a demand for such products.

State of the Topic

In this section we ask how Maine organic production compares that in the rest of the U.S.. We examine the importance of agriculture and organic agriculture in Maine. We describe the state of organic agriculture in Maine based on trends in number of organic producers and location of farms. We explore production and consumption, although the majority of our data analysis addresses production due to greater availability of data in this area. We consider whether national demand for organic products is increasing and if production is also increasing. We demonstrate that Maine is a leader in organic agriculture both in New England and in the nation as a whole.

Organic Agriculture in the U.S.

The number of certified organic farms in the U.S. has grown rapidly since the establishment of national standards. This is evidenced by increasing certified organic acreage (Figure 3.1), increasing numbers of certified organic producers, and increasing federal spending on organic agriculture in the 2008 Farm Bill (Figure 3.2). With production of organic goods on the rise, there has also been growth in the number of farmers markets across the U.S. (Figure 3.3) as well as specialty food stores and restaurants that focus on organic or locally produced goods. Since the reallocation of funds in the Farm Bill was so recent, it is likely that its effects will be observable with delay; however, this increased spending demonstrates a federal commitment to the expansion of the organic industry.

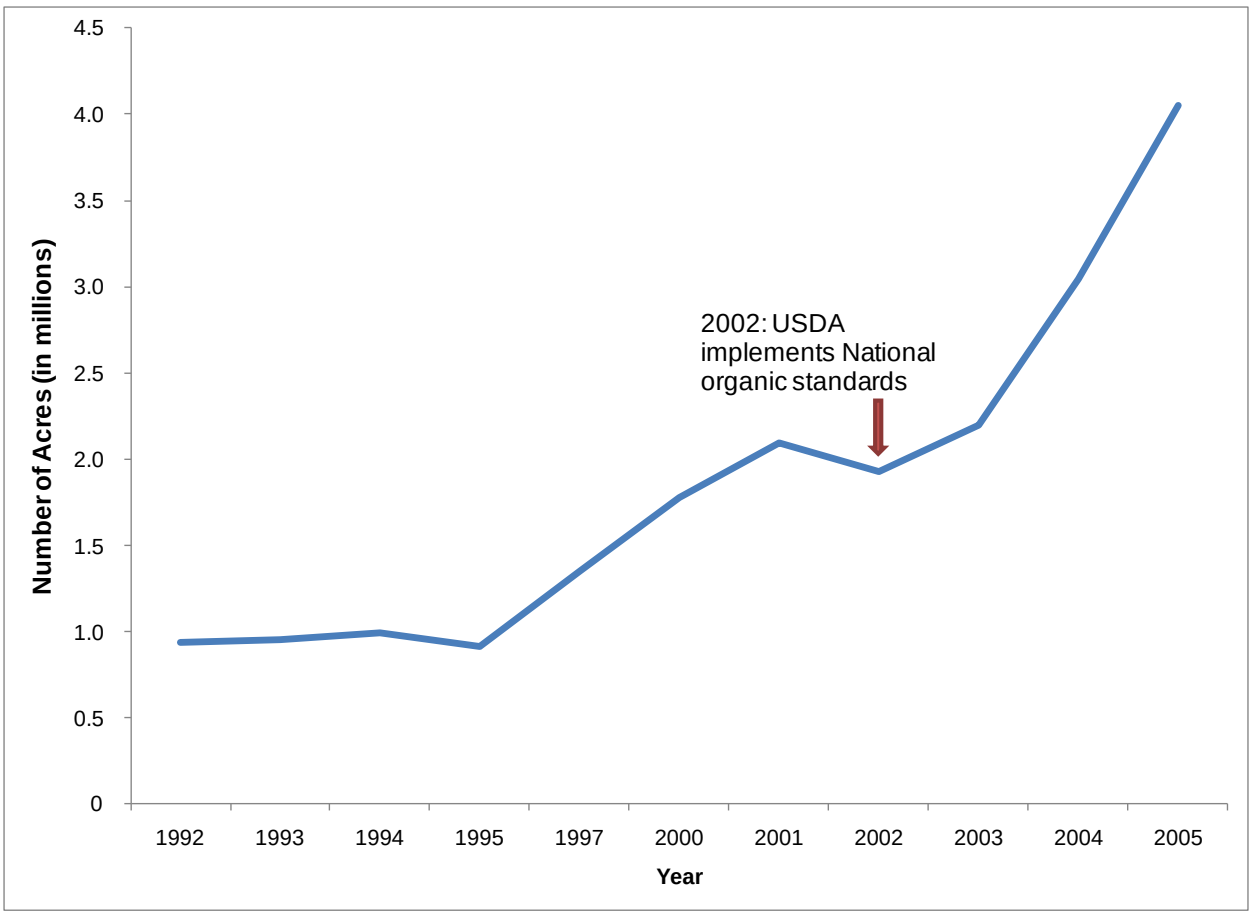


Figure 3.1 Total certified organic acreage in the U.S. 1992-2005 (USDA National Agriculture Statistics Service 2007)

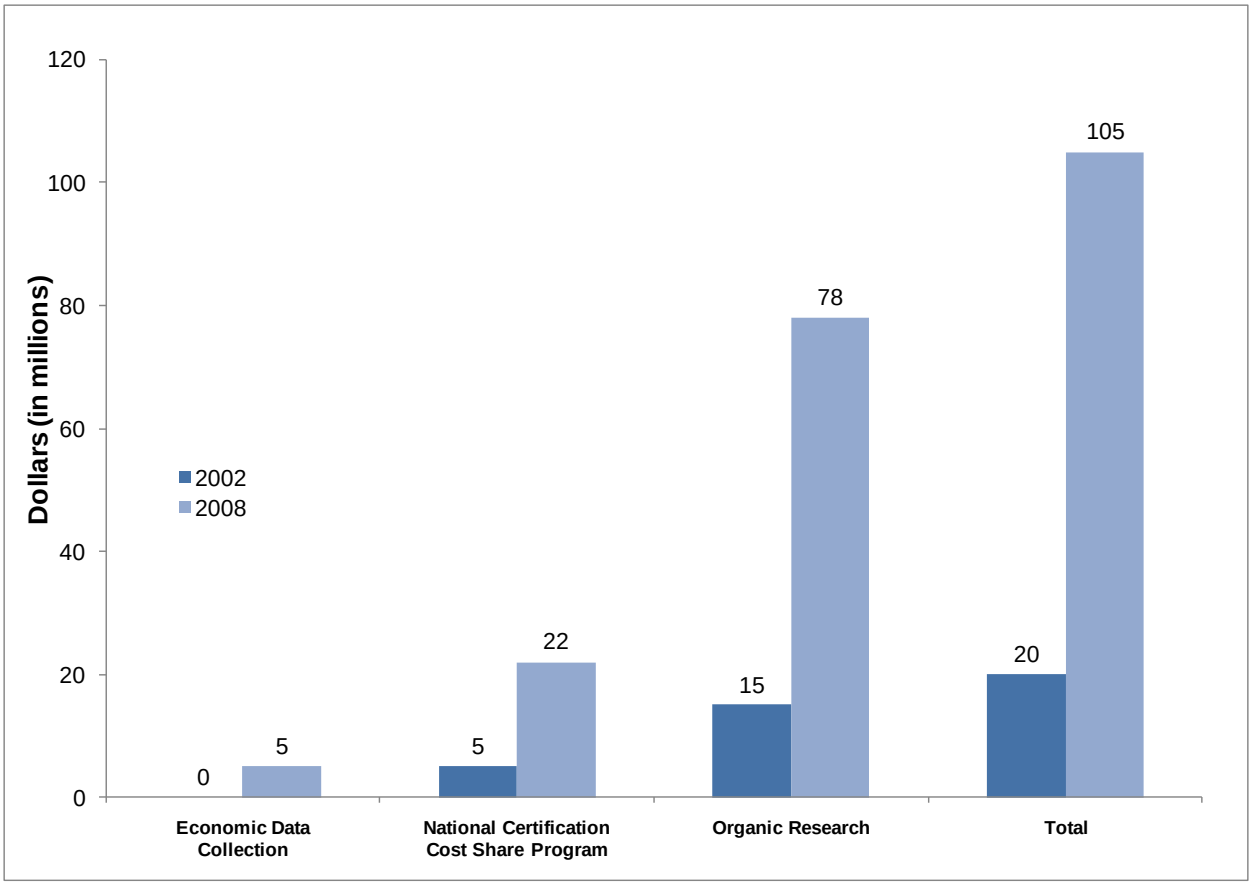


Figure 3.2 Changes in federal spending on organics in the 2008 Farm Bill compared to the 2002 Farm Bill (Greene, Dimitri et al. 2009)

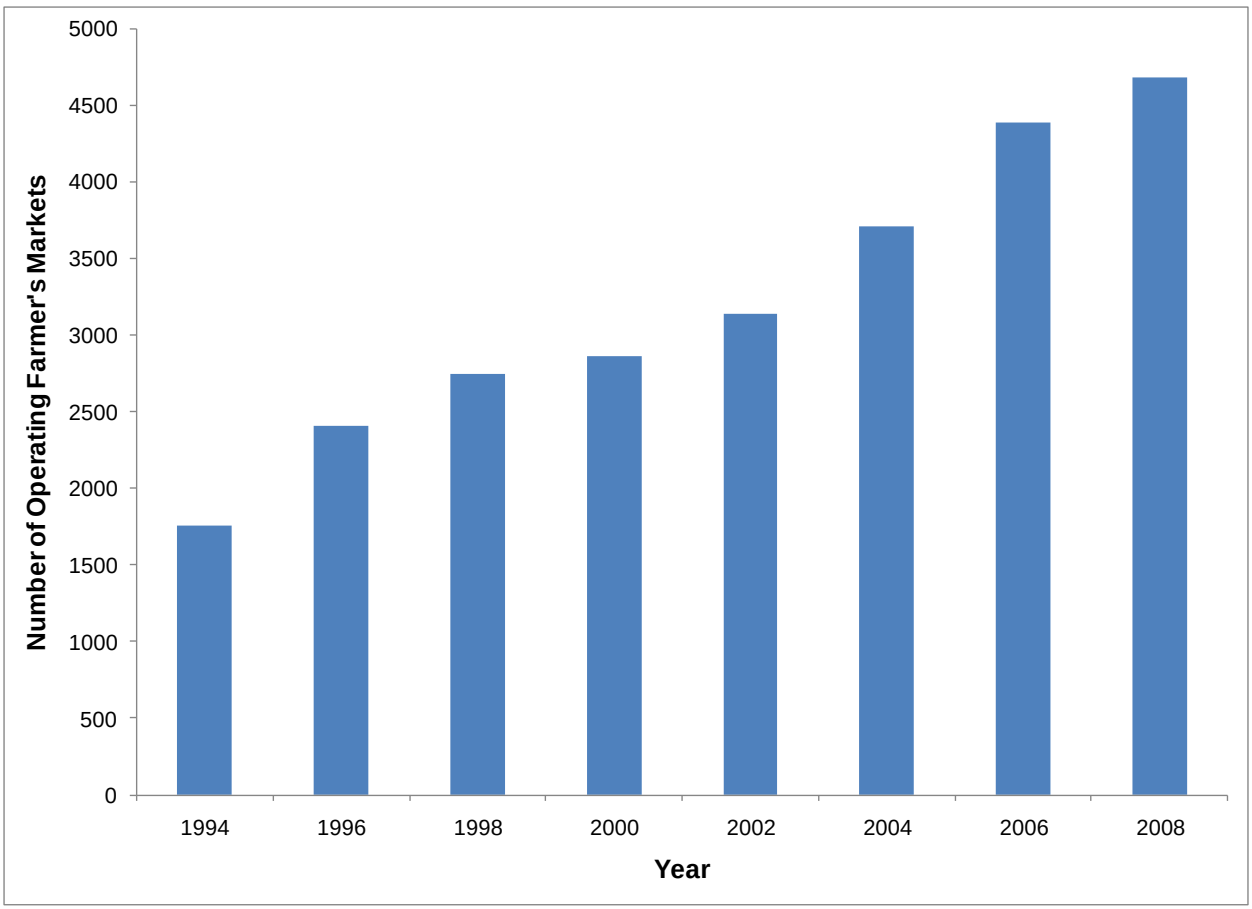


Figure 3.3 Number of farmers markets in the U.S. 1994-2008 (USDA Agricultural Marketing Service 2009)

The success of the organic agriculture market depends on both suppliers and consumers. We limit our discussion to supply because data about consumption trends were too difficult to obtain and is therefore beyond the scope of this study.

Other studies have established there has been growth in demand for organic products in the 1990s through 2005 at roughly 20% each year. This growth is predicted to continue to grow at approximately the same rates through 2010 (Dimitri and Oberholtzer 2006). The primary factors affecting organic consumption include gender, age, level of income, and whether or not consumers have children (Krystallis and Chryssohoidis 2005). Price of organic goods also plays a role in their consumption.

Many organic goods have price premiums, or higher prices, which can be attributed to both increased costs of production and distribution, and additionally, consumer willingness to pay. Increased costs result from many factors including longer crop rotations, increased labor, substitutes for

pesticides, and high prices for organic seed (Greene, Dimitri et al. 2005). According to a USDA publication on price premiums, depending on the product, consumers may be willing to pay up to 100% more for an organic product than its conventional counterpart (Greene, Dimitri et al. 2005).

It is important to note, however, that when the organic movement started, prices and costs were not necessarily limiting factors. Although they are always involved, the first initiatives in organic agricultural production were generally driven by interested farmers with a desire to prioritize the health of both humans and the environment. As awareness increased about the adverse effects of chemicals commonly used in conventional farming practices, demand for organic products grew.

Characterizing Overall Agriculture in Maine

Land Use Change

Nationally farmland is being rapidly converted to other land uses and this trend is also happening in Maine. Between 1950 and 2000, urban areas in Maine increased to 16% of the state's total land area, and suburban areas increased from 3% to 6%. During the same time period agricultural land in Maine decreased by more than 60% (Darling, Hansen et al. 2007).

A report published by the American Farmland Trust (AFT) in 2002 entitled, "Farming on the Edge: Sprawling Development Threatens America's Best Farmland," found that the U.S. was losing farmland to other development at a rate of 1.2 million acres each year between 1992-1997. This was 51% faster than was occurring between 1987 and 1992. The same study showed that the rate of farmland loss in Maine increased 195% between the two time periods, growing from an average of 1,320 acres lost each year to 3,900 acres (American Farmland Trust 2002).

Similarly, according to a 2006 Brookings Report on sustainability in Maine, more than 1,300 square miles of rural land, defined to include both rural fields and woodlots, underwent conversion to residential use in the twenty years between 1980 and 2000. This amount of land is almost the size of the entire state of Rhode Island. During the 1990s, Maine ranked second in the nation based on the share of rural land lost (The Brookings Institution 2006).

Diversity

Relative to the rest of the U.S., Maine has a high diversity of agricultural commodities produced (Figure 3.4). While many states rely on a single

commodity for farm revenues, Maine's agriculture is not heavily weighted toward any one particular commodity. Potatoes, for example, which hold the largest share of total farm sales only comprise 25% (Figure 3.4) (Palmer, G. et al. 1992). Diversity of commodities provides security because if one crop fails due to uncontrollable factors such as weather or spread of disease, a farmer has other sources of income.

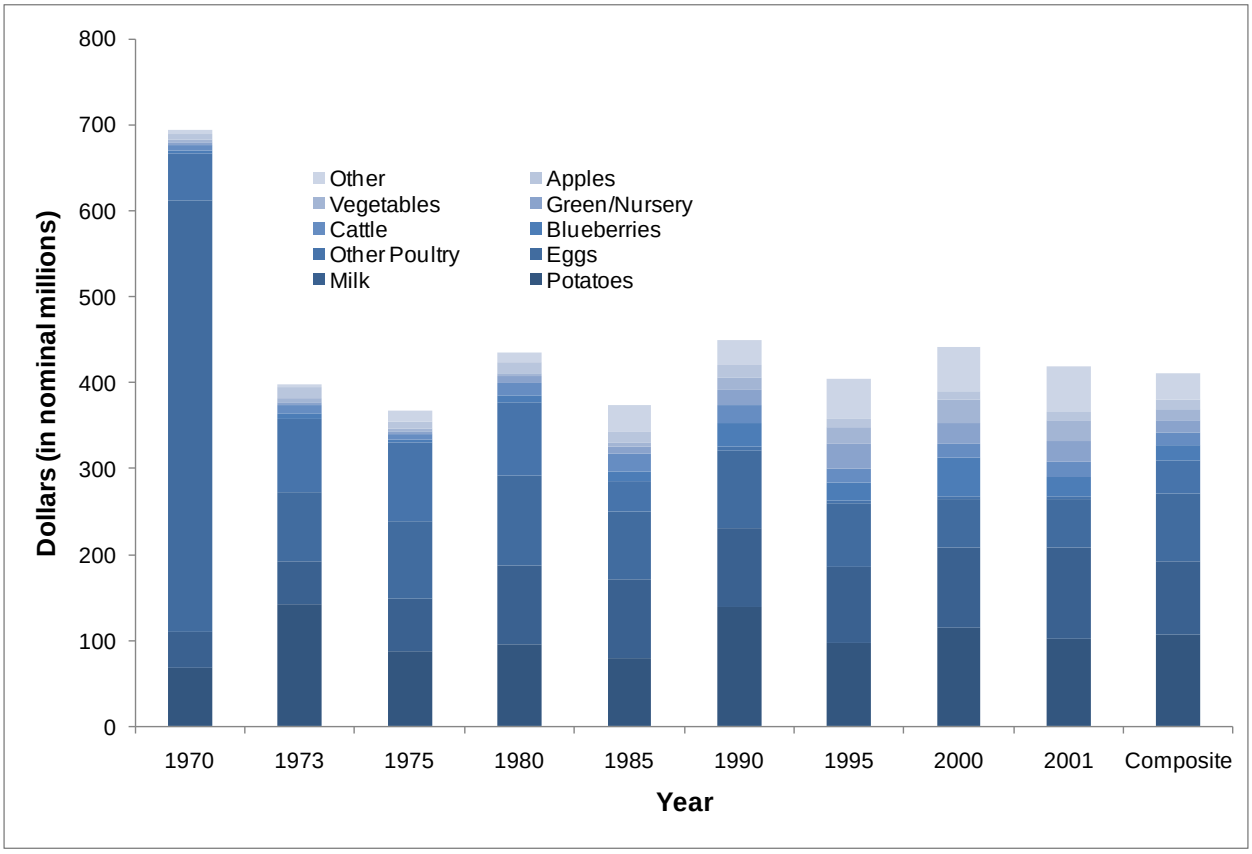


Figure 3.4 Agricultural cash receipts in Maine from selected years 1970-2001 divided by agricultural commodity. (USDA Economic Research Service c 2009).

Number and Size of Farms

The number and size of farms show that Maine has paralleled agricultural production in the rest of the U.S. in some ways, but differed in others. The number of farms in Maine, as well as in the rest of the country at the turn of the 20th century was substantially higher than the current number of farms. In 1880, there were 64,309 farms in Maine, and in 1997 there were only 5,810 (Ahn, Krohn et al. 2002) (Figure 3.5). The decline in agriculture in Maine resulted from relatively poor growing conditions, a transition to other industries, and the industrialization of farming activities, i.e. simplified

farming systems that allowed farmers to operate larger farming units. In addition, larger farms were able to expand by buying smaller farms to increase specialization and economies of scale. These processes of consolidation, concentration, and specialization, paralleling those of the rest of the country throughout the 20th century, shaped the structure of agriculture in Maine (Maine State Planning Office 2003).

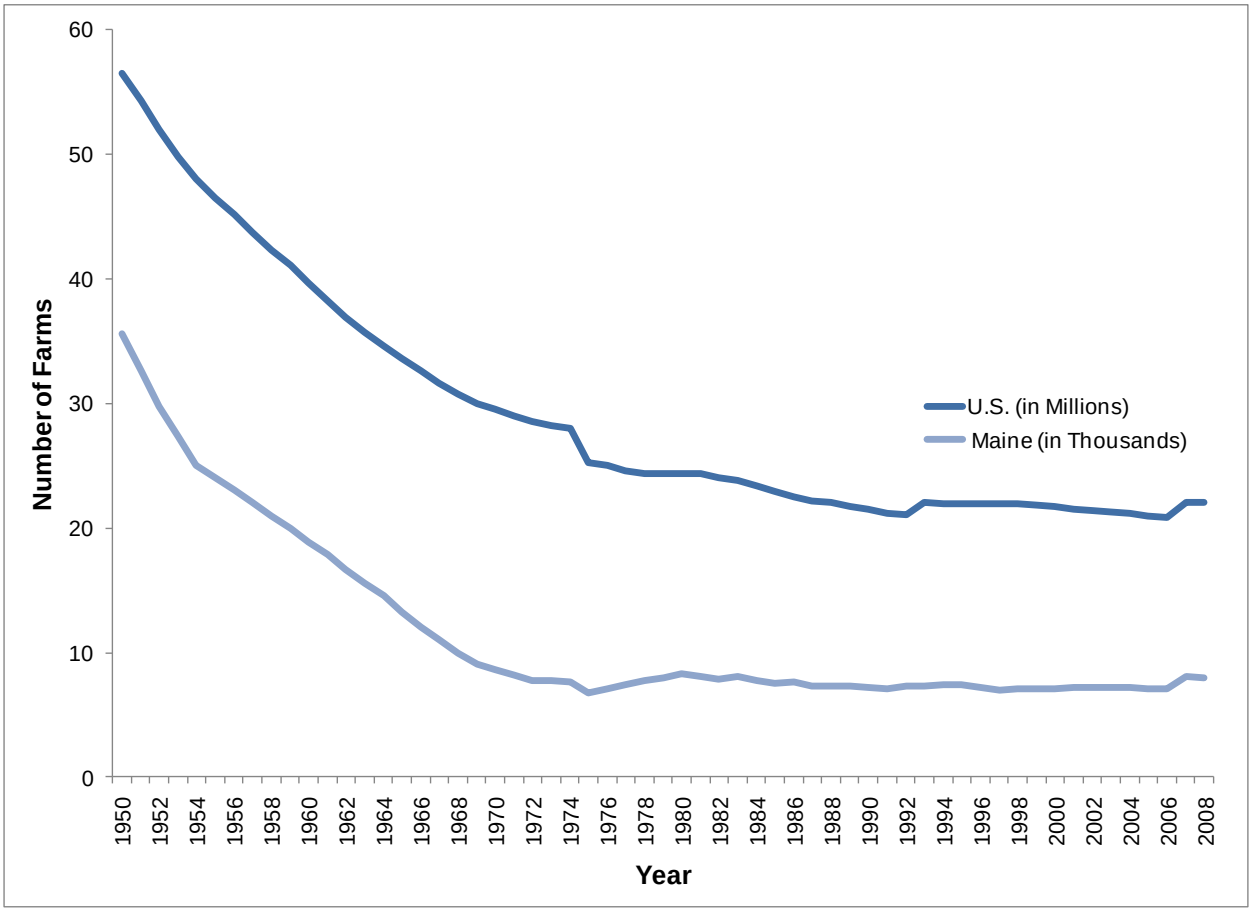


Figure 3.5 Number of farms in Maine and the U.S. 1950-2008 (USDA National Agriculture Statistics Service). The U.S. number is in millions and the Maine number is thousands.

Average farm size in Maine historically has been smaller than average farm size across the U.S. (Figure 3.6). The period of consolidation lasted until 1980 in Maine, at which point the average farm size in the state reached 216 acres and has since plateaued, and even declined (Palmer, G. et al. 1992). In 1950 Maine farms were 42% smaller than U.S. farms, on average and in 1995 Maine farms were 62% smaller than U.S. farms, on average (USDA National Agriculture Statistics Service). Throughout the 1970s as the U.S. average farm size increased, the average farm size in Maine was decreasing. In the 1980s Maine farms began to increase marginally in size,

at a much slower rate than the U.S. as a whole. Since the 1990s farm size has been declining in both Maine and the U.S.

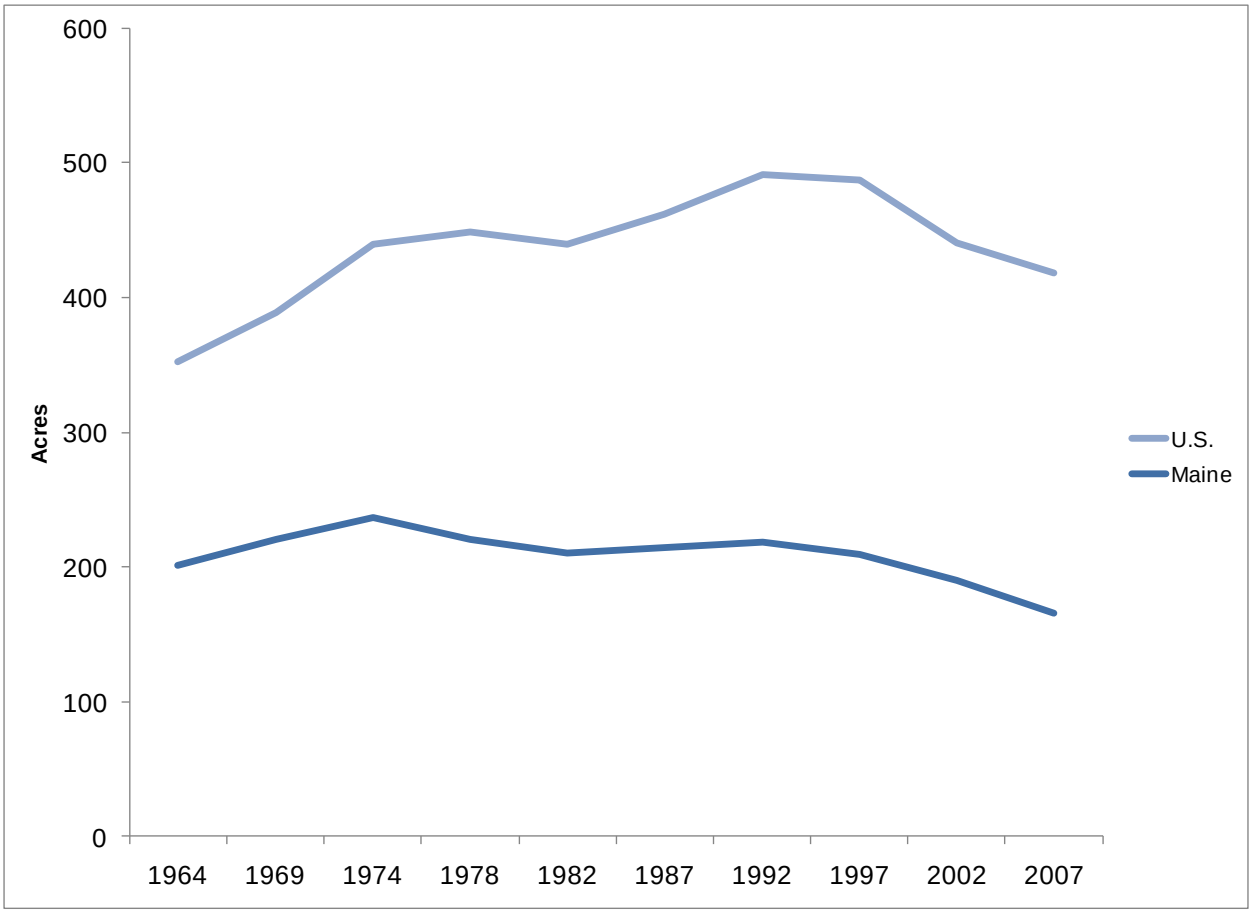


Figure 3.6 Average farm size in Maine and the U.S. from selected years 1964-2007 (USDA National Agriculture Statistics Service)

Organic Agriculture in Maine

In 2008 there were 40,870 acres of certified organic farmland in Maine, up from just over 9,000 acres in 2000. Although Maine's total agricultural land represents only 0.14% of the total in the U.S., and the amount of viable agricultural land is relatively small compared to other states, Maine's certified organic acreage represents approximately 1.5% of the total certified organic acreage in the U.S. (USDA National Agriculture Statistics Service 2007).

There are currently 380 certified organic farms in Maine (MOFGAe 2009). In 2007, Maine had the second highest percentage in the nation of certified organic farms out of total farms in its state. Maine's 3.6% organic farms far exceeded the national average of 0.76%, second only to Vermont (Figure

3.7). On this measure, the top five states in order are Vermont, Maine, California, New Hampshire, and Rhode Island. Notably, all but California, the state in which the organic movement began, are in New England. This may have to do with the organic movement growing in New England alongside the Back to the Land Movement in which those wanting to rebel against urban development and corporate society moved to rural areas to lead an alternative lifestyle by setting up small farms (Jacob 1997; Christensen 2009).

Despite Maine's high ranking, the overall low national shares of organic production demonstrate room for growth in this industry, not only in Maine, but nationwide.

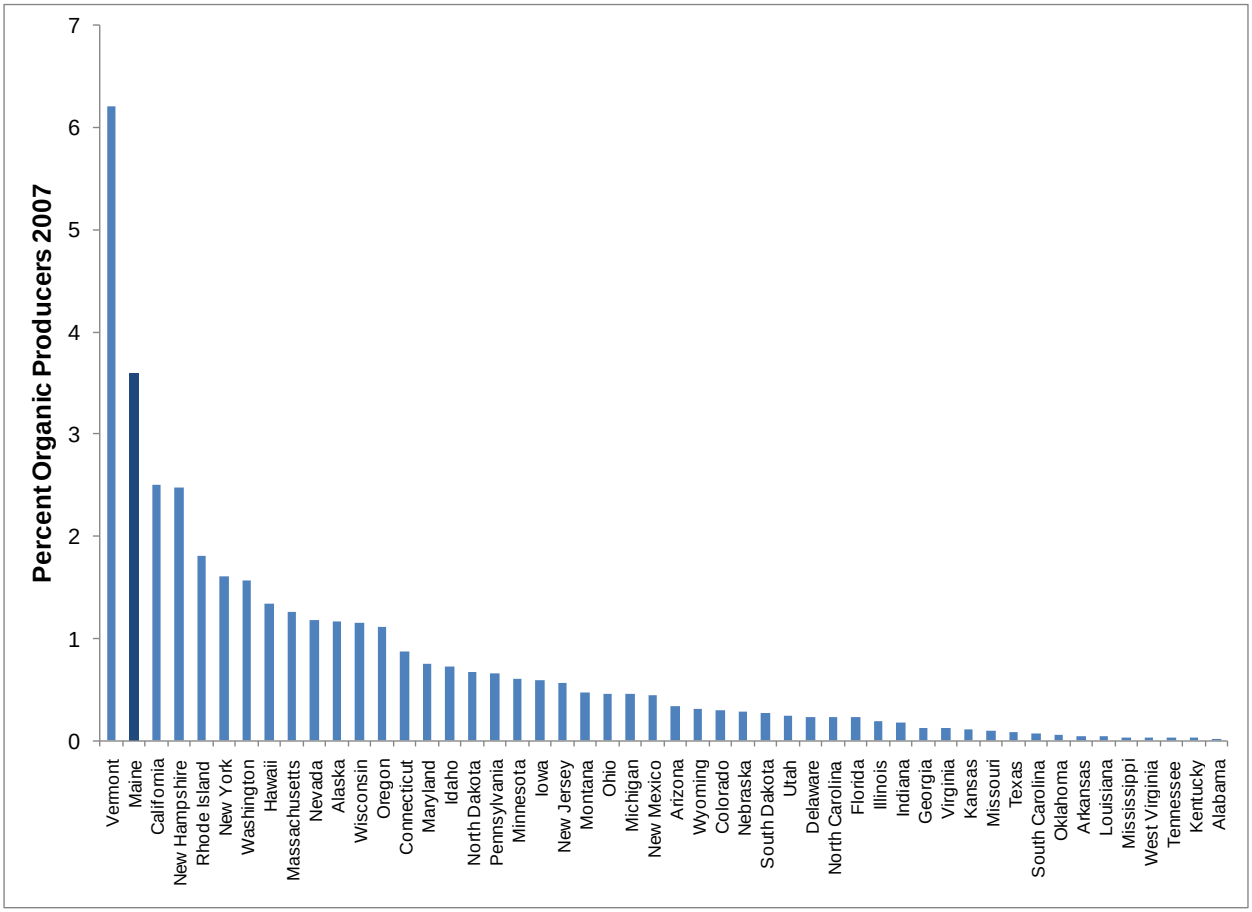


Figure 3.7 Percentage of organic producers out of total agricultural producers in each state 2007 (USDA Economic Research Service d 2009). Maine is second largest, and denoted in a darker color than the other states.

Because national standards for organic agriculture were recently set in 2002, national historical data on organically produced food is limited. However, prior to the establishment of the national standards of organic food in 2002,

Maine and Vermont had more than double the number of organic producers compared to the other four New England States(Figure 3.8). They continue to hold this position today.

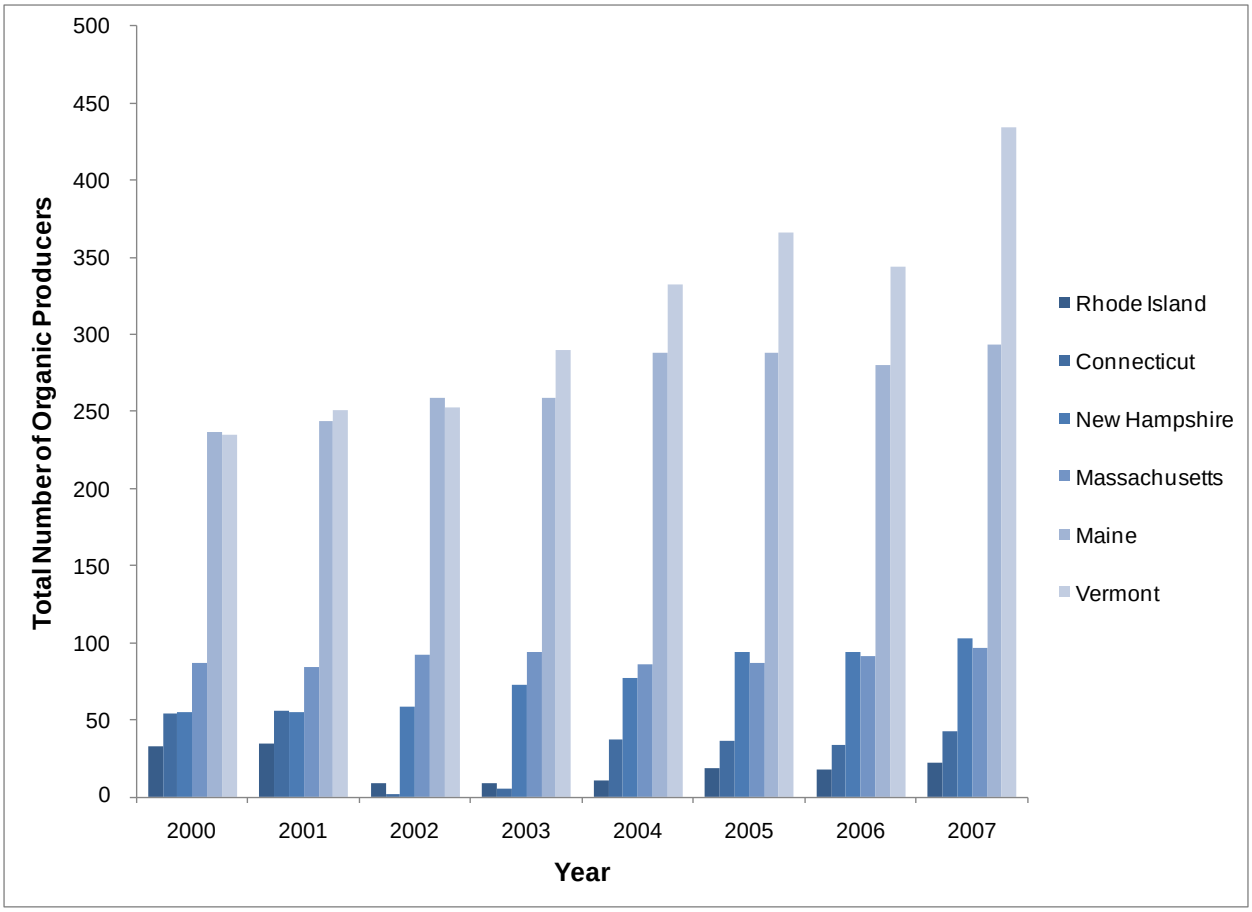


Figure 3.8 Number of organic producers in each New England State 2000-2007 (USDA Economic Research Service d 2009)

Over time, the total number of MOFGA certified organic farms has steadily increased since it began certifying in 1972, with the exception of the early 1990s (Figure 3.9). Vermont, the only other New England state with a combined established organic association and certifier had similar trends to those of Maine in growth of certified organic productions until 2002, when Vermont's growth rate began to exceed that of Maine (Figure 3.10).

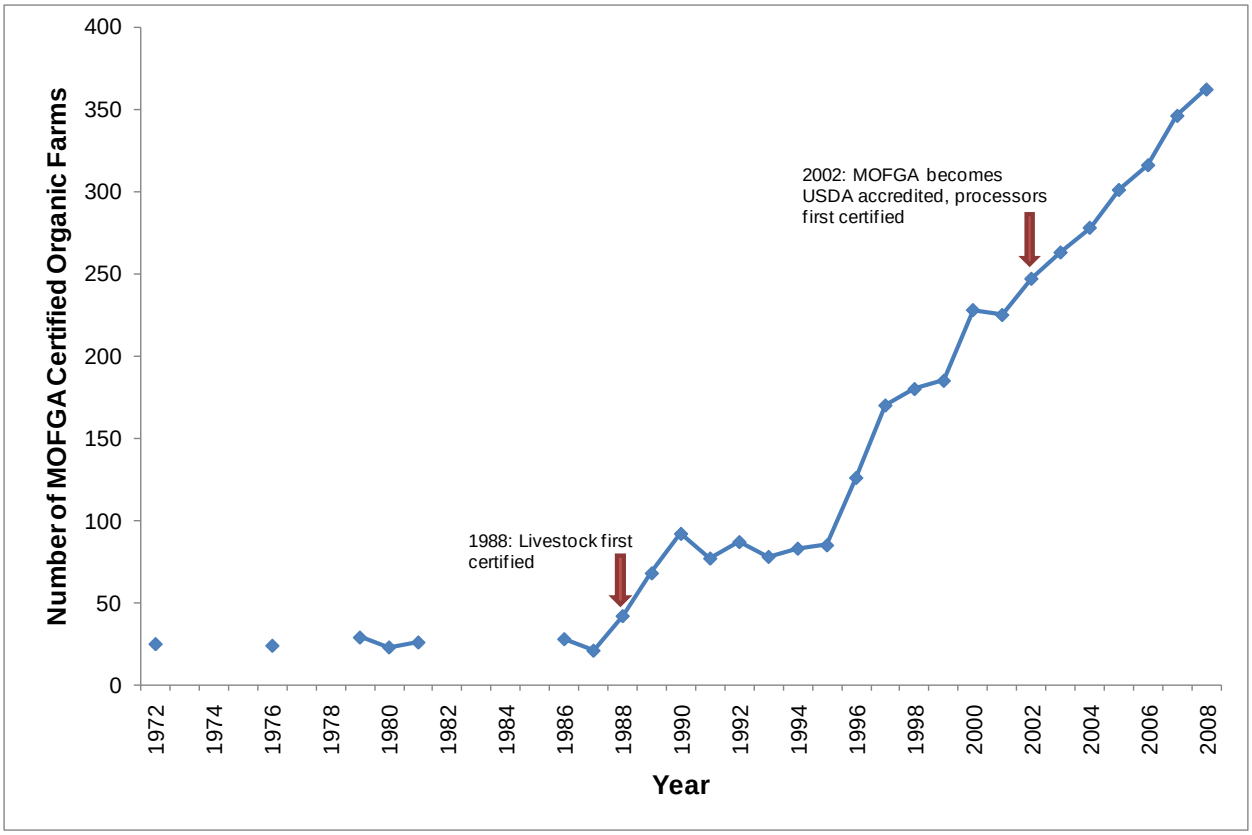


Figure 3.9 Number of MOFGA certified farms 1972-2008 (MOFGAe 2009). Some data is missing in the first few years due to less organized data collection when certification first began.

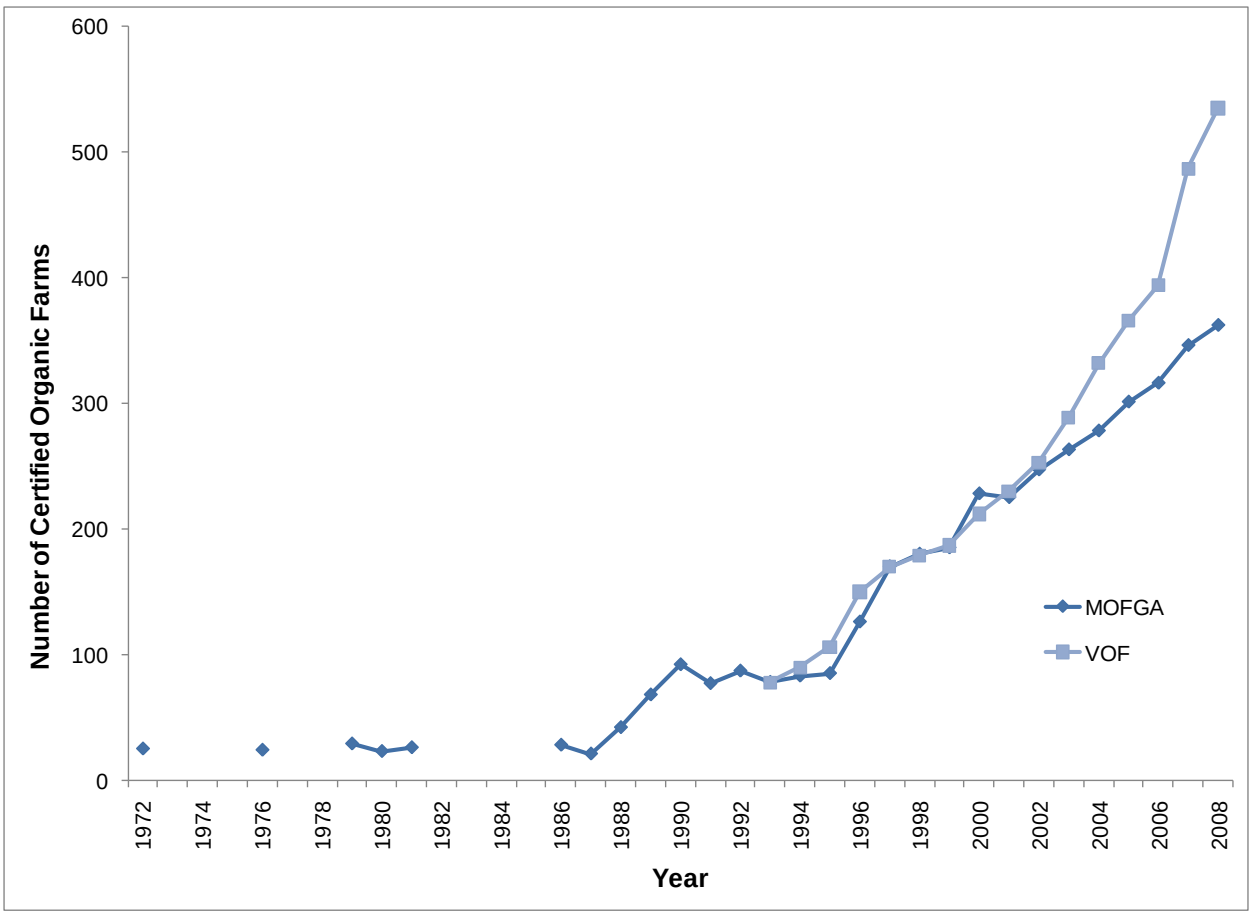


Figure 3.10 Number of MOFGA certified farms 1972-2008 (MOFGAe 2009) and number of Vermont Organic Farmers (VOF) certified farms 1993-2008 (Vermont Organic Farmers 2009).

The leadership of these two states, Maine and Vermont, relative to the rest of New England, is also evident in terms of acreage. The certified organic acreage in Maine and Vermont is considerably greater than the other four New England States and growth of certified organic land in these two states is clear whereas certified acreage in other states has remained low (Figure 3.11).

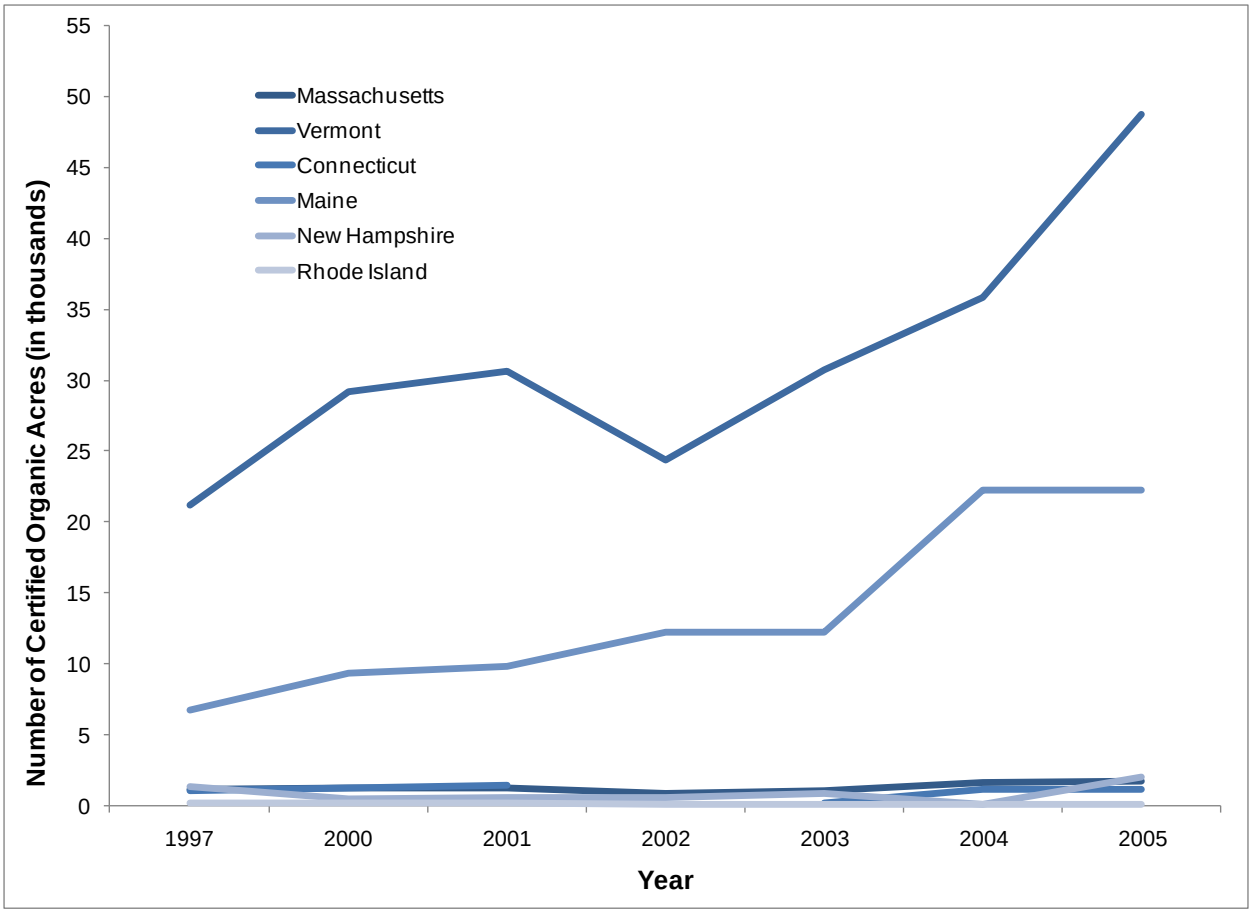


Figure 3.11 Certified organic acreage in each New England state 1997 and 2000-2005 (USDA Economic Research Service d 2009)

Locations of Organic Farms in Maine

In order to learn more about the location of organic farms in Maine we created two maps with a point on the location of each MOFGA certified organic farm. We found that Maine organic farms are concentrated in the southeastern part of the state, with a small cluster of farms in the northern part of the state, Aroostook County (Figures 3.12 and 3.14). Several factors affect this trend including availability of developable land, access by roads, and population density.

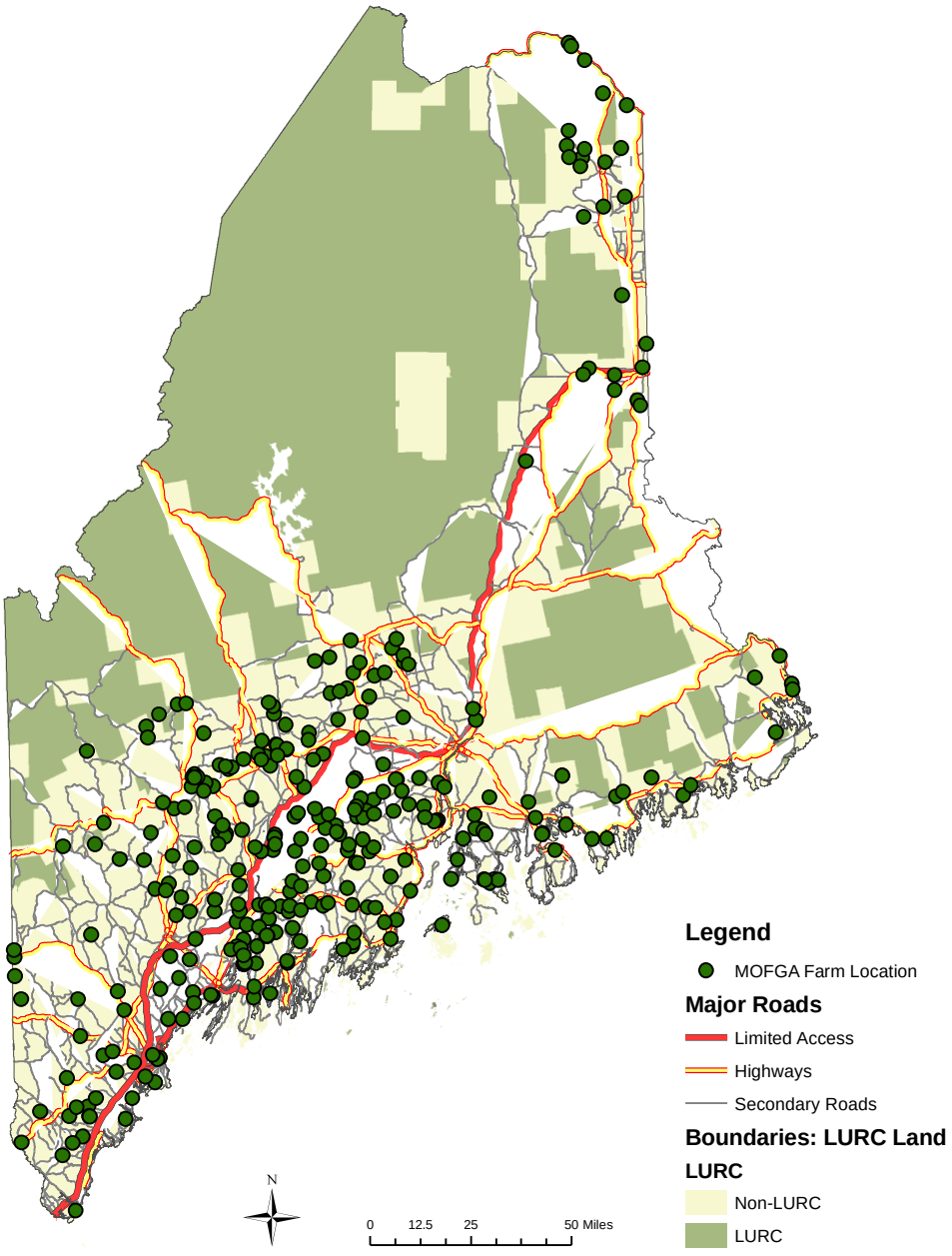


Figure 3.12 Location of MOFGA certified farms and major roads. Land under the jurisdiction of the Land Use Regulation Commission (LURC) appears in green.

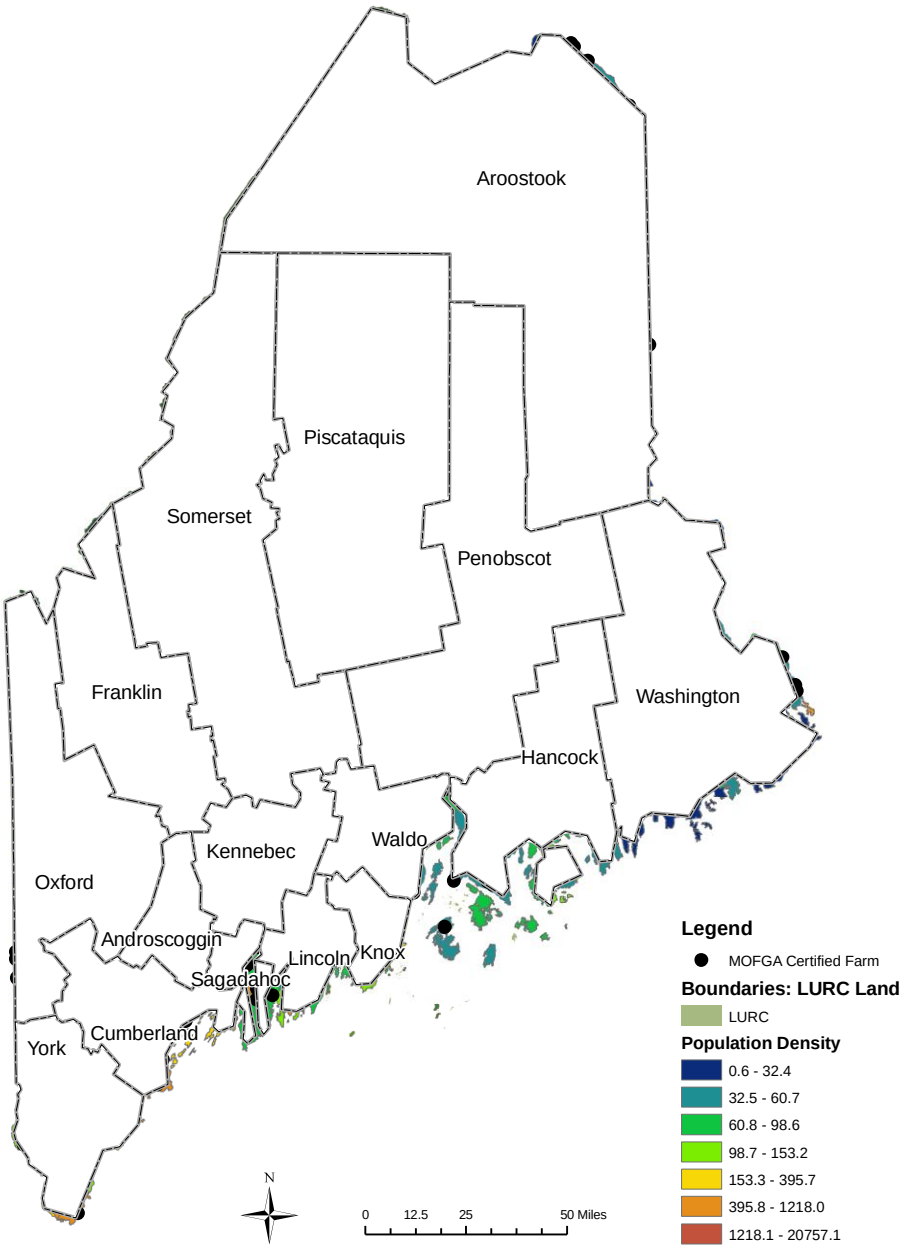


Figure 3.13 Location of MOFGA certified farms and population density. Land under the jurisdiction of the Land Use Regulation Commission (LURC) appears in green.

Maine is broadly divided into two categories of land: land in the "Unorganized Territory" under the jurisdiction of the Land Use Regulation Commission (LURC), and land in the organized territories, non-LURC land. It is the non-LURC land where most people live and where most development in the state takes place. Consequently, viable agricultural land and land for residential use is limited to a small land area and thus most farms are contained in this area. Additionally in 2000, 90% of Maine was covered by forests (most of which is within the LURC territory) making it the most forested state in the nation (Schwartz, Sinnott et al. 2007) thereby further limiting the availability of farmland.

We estimated how many certified organic farms and conventional farms were in each county as described in the methods section. We also calculated the percent of farms in each county that are organic and the percent that are conventional (Table 3.3). Waldo is the county with the highest percentage of organic farms and Oxford County has the highest percentage of conventional farms. By rank, comparing the top five counties that have the most certified organic farms with the top five counties that have the most conventional farms, Kennebec County had the highest number of organic farms while Aroostook County had the highest number of conventional farms (Table 3.4). Only two counties, Kennebec and Aroostook, rank in the top five for both types of farm.

Table 3.3 Number and percentage of organic and conventional farms in each Maine county

County	Total Farms	Organic Farms	Conventional Farms	% Organic	% Conventional
Androscoggin	378	13	365	3.4	96.6
Aroostook	1246	26	1220	2.1	97.9
Cumberland	630	21	609	3.3	96.7
Franklin	388	17	371	4.4	95.6
Hancock	386	24	362	6.2	93.8
Kennebec	649	42	607	6.5	93.5
Knox	304	10	294	3.3	96.7
Lincoln	363	20	343	5.5	94.5
Oxford	545	10	535	1.8	98.2
Penobscot	706	16	690	2.3	97.7
Piscataquis	190	7	183	3.7	96.3
Sagadahoc	183	14	169	7.7	92.3
Somerset	564	30	534	5.3	94.7
Waldo	424	37	387	8.7	91.3
Washington	472	10	462	2.1	97.9
York	708	16	692	2.3	97.7

Table 3.4 Each Maine county and its ranking in two categories: number of organic farms, and number of conventional farms

County	Ranking	
	Organic	Conventional
Aroostook	4	1
York	10	2
Penobscot	9	3
Cumberland	6	4
Kennebec	1	5
Oxford	14	6
Somerset	3	7
Washington	15	8
Waldo	2	9
Franklin	8	10
Androscoggin	12	11
Hancock	5	12
Lincoln	7	13
Knox	13	14
Piscataquis	16	15
Sagadahoc	11	16

It is clear from the maps that within the organized territory, organic farms in Maine are located in areas of high population density and near to major roads. Such location helps to minimize costs related to transportation, marketing, and processing. By creating virtual buffer zones around the major roads in Maine (this included the limited access roads, and the highways), we were able to determine how many organic farms were located within a given distance from these roads (Table 3.5). The high proportion (90%) of the certified organic farms within 10 km of a major road demonstrates that accessibility is critical to organic farm location. Unfortunately without the street addresses of every conventional Maine farm, we cannot compare organic to conventional farm location; however, we expect that conventional farms would illustrate a similar trend.

Table 3.5 Number of MOFGA certified organic farms located within given distance of major roads (including limited access roads and highways)

Buffer Zone (km)	Number of Organic Farms	% of total
1	64	20.4
5	199	63.6
10	282	90.1
15	301	96.2
20	307	98.1
25	313	100.0

Implications

National Organic Trends

Pros and Cons of the National Organic Program

By establishing national standards, the National Organic Program (NOP) brought national attention to organic agriculture, which had and continues to have a powerful influence on all stakeholders. Such attention has influence on both farming decisions and consumer demand. On a federal level, establishment of the NOP has had numerous implications for the organic agriculture industry in the U.S.

As demonstrated by the increase in number of certified farms since the passage of national standards, the NOP is recognized as being partially responsible for the recent, rapid growth of the organic industry. This has contributed to the increase in national demand for organic goods. An increase in certified farms makes organic food more readily available and uniform labeling makes it more easily identifiable as organic. Additionally the more organic farms there are, the greater the environmental benefits.

There are also several downsides to the establishment of national organic standards. Almost everyone we interviewed about organic agriculture in Maine expressed some dissatisfaction with the system of national standards. One problem is that many people think they know what organic means when in fact the definition and standards outlined in the NOP are long, and complex, and often difficult to comprehend. Although many consumers associate the term "organic" with small family farms, the NOP allowed the industry to grow such that certified organic farms can also be large,

industrial operations. Currently, the standards do not differentiate between a large, industrial organic producer and a small family farm because both can be certified under the same standards. Thus there are both benefits and consequences hidden in such a narrow definition.

Another consequence of a uniform definition of organic agriculture is that it limits interpretation, thereby excluding those organic farms that are not USDA certified from being officially organic and allowed to market their products as such. One negative effect of this is that uncertified organic farms do not get included in research and statistical analysis of organic farms. Our estimates of the level of organic production in the U.S. and in Maine as measured only by those who are USDA certified therefore likely under represents the number of farms employing organic practices.

There are a variety of reasons for farmers to not become USDA certified organic. Certification has both direct costs to farmers including paying a certification fee, and indirect costs including meeting production requirements and completing paperwork. Additionally, several farmers we interviewed expressed dissatisfaction with the physical process of certification. Before national standards, the process was educational and communicative; certifiers would inspect the farm but also share information and ideas about most effective methods in farming organically. Since MOFGA became an accredited USDA certifier, the process of organic certification changed to an evaluation of whether or not USDA organic standards are met. Lastly, standards outlined in the NOP do not adjust based on varying climates across the U.S. thus posing challenges for some farmers where growing conditions are not ideal (Lawn 2009).

Increased Federal Spending on Organic Agriculture in the 2008 Farm Bill

Farm Bills, passed every few years, are major federal legislation with implications for organic farming and are subject to political lobbying. Because of the complexity and comprehensiveness of Farm Bills, there are dozens of stakeholders with varying and competing interests all lobbying for different policy. The consolidation of farms in the 20th century enabled a few large and powerful producers of agricultural commodities to have greater influence in federal legislation. It is thus likely that the increased federal spending in the 2008 Farm Bill is in the interest of the more industrial organic farms, which serve to gain a greater profit from the increased market value of organic goods.

MOFGA's Role in Maine's Status as a Leader in Organic Agriculture

With the creation of the Maine Organic Farmers and Gardeners Association (MOFGA) in 1972, Maine became a pioneer of organic production and certification well before the establishment of national standards. Little national data exists on organic production prior to 2002, largely because many states did not have certification programs before implementation of the NOP. However, the existence of certified organic farm data for Maine spanning more than thirty years demonstrates an early commitment to organic research and documentation, unavailable in many other states.

MOFGA additionally provides support and numerous resources for organic farmers in Maine. In New England, the services of MOFGA are paralleled only by the Vermont chapter of the North East Organic Farmers Association (NOFA-VT). Unique to MOFGA, however, is their inclusion of both those who make their living from farming, farmers, as well as those who do it recreationally, gardeners. This allows for a broader membership base and larger support for the association.

Influence of Overall Agricultural Trends on Organic Agriculture in Maine

In this section we explore probable connections between overall agricultural trends and organic agriculture in Maine.

Land Use Change

Rapid transition of farmland to other types of land use in Maine poses a major threat to organic agriculture. Because of increased production costs associated with organic farms it is more difficult for organic farmers to profit from their farms and are thus more likely to be tempted to sell their land to developers.

Diversity

A major tenet of organic agriculture is soil health. In addition to providing security for farmers, diversity of crops is also important for soil health because different crops use different nutrients. If one crop is repeatedly planted on one plot of land, the soil can become drained of nutrients that the crop requires and may necessitate the use of artificial fertilizers to assist in the nutrient cycle. A diversity of crops, however, allows the soil to replenish its nutrients as different crops are planted over time.

In places where the agricultural economy depends entirely on one crop, it is likely that there are many different stakeholders and laws primarily addressing that specific crop. In Maine, a diversity of crops allows for a variety of legislation regulating different kinds of agriculture rather than focusing on one commodity.

Farm Size

Organic agriculture seems best suited for small scale farming for a variety of reasons. Organic methods of pest control are more expensive and more difficult to employ on larger farms. Price premiums for organic goods provide an incentive for quality over quantity therefore reducing the need for large farms that produce large quantities. Additionally, since consumers are often willing to pay more for organic products, there is an incentive to transition to organic because although costs are higher, farmers can also charge more for their products.

We hypothesize that farm size is a potential indicator of organic farming as the average organic farm is smaller than the overall average farm size. In 2002 the average size of an organic farm in the U.S. was 263 acres while the average farm size overall was 441 acres (USDA National Agriculture Statistics Service 2007). Therefore, the entry of small farms in Maine is a possible indicator of growth in organic agriculture in the state.

Location of Farms in Maine

We discuss possible explanations for the trends we found in the location of organic farms in Maine based on the maps we created. Additionally we explore the benefits and drawbacks to these trends in location.

In determining the approximate number of organic and conventional farms in each county, we found that only two counties, Aroostook and Kennebec, ranked in the top five for both types of farm. This suggests a difference in location between certified organic farms and conventional farms. One possible explanation for this has to do with a standard outlined in the National Organic Program (NOP) that requires an organic buffer zone around a farm in order to become certified organic. The major implication of this rule is that some farms practicing organic methods and want to become certified simply cannot based on proximity to farms that use chemicals prohibited in the NOP. Aroostook county, for example, though ranking top five in both types of farm, has 1178 more conventional farms than organic. Although Aroostook County is known for its relatively large scale potato farms, there are potentially more farms in the county practicing organic methods but are too near to the conventional farms to become certified.

Another reason that location may vary has to do with varying quality of land. Conventional farms have generally been established longer than organic farms and thus likely claimed the most fertile land first. Due to the recency of growth in organic agriculture, many certified organic farms are run by first generation farmers for whom the top choice of land may not have been available when the farm was established.

Eight counties fell within this the top ten ranking for both organic and conventional farms. This suggests a more subtle difference between the locations of the two, than is evident just by looking at the top five.

Another trend we found was proximity to major roads, defined to include limited access roads and major highways. This is particularly noticeable in looking at the cluster of farms in Aroostook County that appear to be situated only surrounding I-95 and ME-1. This demonstrates that accessibility is critical to the location of organic farms. Nearness to roads helps to reduce costs to the farmer associated with transportation. Additionally distance between consumer and producer is minimized. This demonstrates a link between local and organic agriculture.

Related to the location trends near major roads, we found that certified organic farms tend to be located in areas of high population density. This is also an indicator of the importance of accessibility. Farmer's markets, for example, are often prevalent in high population dense areas making local food more easily available and increasing communication between consumers and the farmers who grow their food. Clusters of farms in Washington County exemplify this trend as they only appear in the most population dense areas of the county.

It is important to note, however, that a major drawback to having farmland in high population dense areas is the increased pressure to develop into other types of land use as a result of development needs to accommodate the growing population. As Maine works to conserve its farmland, those farms in areas of high population density will face the most pressure to develop for other uses.

Scenarios

Based on our conclusions about current organic food trends in Maine relative to the rest of the U.S., we propose two scenarios for the future of organic food production in Maine. Recent national trends indicate growth in demand for organically produced foods at a rate of 20% each year (Dimitri and Oberholtzer 2006). As the effects of climate change intensify and awareness increases about the consequences of large scale, conventional farming, we

expect farms will continue to transition to organic production. We therefore assume, in both of the following scenarios, that national demand for organic products continues to grow, and that supply in both Maine and the rest of the U.S. will continue to grow to meet demand. Factors such as an unstable economy have the potential to decrease demand and are important in examining the outlook in organic agriculture. However, in our scenario planning, we assume a renewed interest with economic recovery.

Our proposed scenarios address the growth of organic agriculture in Maine relative to the rest of the U.S. In the first scenario, Maine maintains its status as a leader with a high percentage of organic producers out of total agricultural producers in its state. The second scenario predicts that Maine's rank in terms of percentage of organic producers decreases as other states increase organic production in their states. In these two scenarios we also examine potential changes in the composition of demand for Maine goods, and differences in factors influencing production.

"Bountiful Harvest": Maine Remains a Leader In Organic Production

In this scenario Maine continues to be leader in the U.S. for organic agricultural production. The strength of MOFGA would increase as a result of the success of state and federal programs promoting organic consumption. Efforts to conserve farmland would be successful and rates of farmland loss would slow. Additionally, incentives would increase for farms to transition to organic methods of production and farms in Maine would continue to become certified at an increasing rate. In this scenario the success of organic agriculture in Maine would serve as a model for the growth of organic farms in other states.

A report from the Brookings Institution report identifies the importance of quality of place to Maine's economy (The Brookings Institution 2006). Similarly, the Maine State Planning Office (SPO) recognizes trends impeding growth in Maine's natural resource-based industries and recommends ways to address them in the report, Blaine House Conference: Chart a New Course (Maine State Planning Office 2003).

Following the recommendations of these reports, recent legislation has demonstrated that Maine legislators have given a high priority to the promotion of local consumption of Maine produced foods. These laws address issues including support from development pressures, recognition in deficiencies in data, the importance of Maine branding, and support for small businesses.

If these policies are effective in meeting their objectives, commodities such as potatoes and dairy, which are primarily distributed out of state, may continue to increase to match national demand. Additionally, initiatives promoting local foods, as well as the expansion of farmers markets in Maine could increase direct local consumption.

"Frozen Fields": Maine Falls Behind in Organic Production

Organic agriculture in Maine has historically benefited from the support of MOFGA, and this benefit continues today. However, as the organic industry continues to grow nationwide, Maine's role as a leader in percentage of organic agriculture production may be overtaken as the organic industry grows larger in states where agriculture represents a greater proportion of their economy due to factors such as better overall climates conditions, land area, and historical importance of agriculture. Increasing supply of organic goods may drive down their price and thus pose challenges for small organic farms in Maine to maintain the more costly organic practices. Additionally, if efforts to conserve farmland are not successful, Maine faces the loss of valuable agricultural land, thus impeding the success of agriculture in the state.

In this scenario, although Maine may fall behind in terms of organic production, Maine has the potential to become a leader in local consumption. Decreasing emphasis on organic production in the state would create the opportunity for Maine to establish a leadership role in terms of the amount of local agricultural commodities that are consumed in the state.

Conclusion

Although Maine is heavily forested, and agriculture represents a small portion of its economy, a community of small farmers has been growing in the state since the 1970s, and the maintenance of agriculture in Maine is an important part of its "quality of place" (The Brookings Institution 2006). Additionally, increasing agriculture in the state has the potential to boost Maine's economy.

Organic agriculture is a market in Maine that is relatively distinctive to the state and has the potential to grow. Maine has proven to be a leader in small, organic farming, and these farming methods influence the health of both Mainers and their environment.

Recommendations

We propose recommendations to Maine policy makers about how to address the future of organic agriculture in Maine.

Increase Local Food Consumption

While organic methods provide advantages for both human and environmental health, increased consumption of local agriculture also has environmental benefits and economic advantages. Maine farms could see substantial increases in farm income if more of Maine's food were to be supplied by local agriculture. With increased income, farmers may have greater ability to meet the increased production costs of becoming certified organic. Furthermore, many of the ideological reasons for consuming locally are intertwined with reasons for consuming organic agriculture.

While it is important for Maine to promote organic agriculture, we recommend that Maine place additional emphasis on local and sustainable food. We propose three methods by which this can be achieved: developing a local sustainable label, increasing processors and distributors in the state, and increasing the number of colleges and universities that supply local food.

Sustainable Local Food Certification

While the existence of national organic standards provides a way for farmers to prove and advertise their organic practices, they exclude those farmers who chose not to participate in the certification process. This has implications for consumers in Maine as they may learn to value an organic label when in fact many local farms are practicing organic methods but are not certified.

We recommend that similar to the organic label, a sustainable local label be created to identify foods produced in Maine with sustainable methods. Maine should develop a system of identifying and classifying local farms that employ sustainable practices but are not U.S. Department of Agriculture (USDA) certified organic. A unique "Produced Sustainably in Maine" label could help to distinguish these farms from more industrial farms in Maine that use many external inputs and do not practice sustainable methods. One way to measure this would be to measure the distance the food traveled from its point of production. Some farmers markets already control for this, but we recommend standardized criteria for markets within Maine.

There is currently a campaign sponsored by the Maine Department of Agriculture Food and Rural Resources (MDAFR), to promote Maine produced foods with a label, "Get Real. Get Maine!" (Get Real Get Maine 2003). However, this label does not necessarily account for differences between sustainable and non-sustainable agricultural practices. A possible collaboration between the Maine Organic Farmers and Gardeners Association (MOFGA) and MDAFR could work towards establishing a sustainable local label.

One potential drawback to a sustainable local label is that it could create competition for USDA certified organic foods. In developing a local sustainable label for Maine, it would be necessary to address this conflict so as to allow for the successful coexistence of both labels.

Increase Processors and Distributors

A large portion of the value of agricultural goods is added when they are processed. In order for Maine to increase the value of its farming industry, it is important to develop more processors and distributors in the state. Although most farms in Maine are relatively small, the state is short of processors and distributors to handle commodities produced by its farms. There is great potential for an increase in local food consumption with the addition of in-state processors (Hayward 2009).

Smaller, diversified farms generally have higher costs if supplying out of state, but increased opportunities for intrastate supply could decrease these costs. The addition of such facilities would create economic opportunities for farmers and also make it more convenient for suppliers such as restaurants to purchase local foods.

Ease Local Supply for Maine Colleges and Universities

There are 39 colleges and universities in Maine; thus students in Maine have the potential to make up a large market for local agriculture. Only seven colleges and universities in Maine have alternative food programs (Appendix B). Of these seven, five are private institutions. According to Joe Klaus, Assistant Director of Dining Services at Colby College, there are challenges to supplying local and organic food for colleges and universities.

In spite of these challenges, however, colleges and universities have the potential to be large markets for locally grown food. We recommend that more colleges start student-run organic farms on their campuses to educate the students and staff about food production, as well as contribute to local food for college consumption. Additionally, we recommend a "Presidents'

Local Food Commitment" in which college and university Presidents could sign an agreement to prioritize local food supply at their institution. This could be modeled after the existing "Presidents' Climate Commitment" which, to date, 663 American college and university presidents have signed, agreeing to conduct an emissions inventory, set a target date for carbon neutrality, and take immediate steps toward greenhouse gas reduction at their institution (Presidents' Climate Commitment 2007-2009). There also currently exists a College Sustainability Report Card, which provides sustainability profiles for hundreds of U.S. colleges. It includes a Food and Recycling section that addresses the local food supply of each college (Sustainable Endowments Institute 2009). In accordance with this report card system, signing a local food commitment could add to the institution's grade in the Food and Recycling category.

Conserve Farmland

The future of agriculture in Maine depends upon Maine recognizing the importance of farmland and prioritizing its conservation. As farmers face development pressures, farmland in Maine is at risk for conversion to other use, which is difficult to reclaim as soil conditions change. In order to reach the agricultural potential of the state, it is important that Maine provide fiscal assistance to farmers at risk of selling land for development. The Land for Maine's Future Program is currently working to create incentives for farmers to maintain their farmland (Maine State Planning Office b 2006). The Brookings Report recommends development of a Quality Places Fund in Maine which, among other things, would fund farmland conservation (The Brookings Institution 2006). We recommend a form of subsidy provided to farmers for conserving their farmland. The funding for such a program could be written into the next Farm Bill and could presumably apply to other states for which farmland conversion is also an issue. Farms would receive the subsidy based on the number of years in operation.

Reduce Costs of Organic Production and Consumption

As discussed, costs of production of organic agricultural commodities are currently higher than costs of producing conventionally, thus creating a disincentive to transition to organic. This often equates to higher cost prices for consumers. Reducing costs to organic producers and to farmer transitions to organic production may allow producers to provide organic goods at lower prices. Thus, although consumers are often willing to pay price premiums on organically produced goods, reducing costs for farmers may make organic food available to a broader range of people. As funds in the 2008 Farm Bill increase for organic agriculture, this should contribute to the provision subsidies for organic producers.

Increase Data and Information

The recent growth of organic agriculture across the nation has outpaced the collection and publication of useful data available to the public. Data on organic agriculture would help policy makers, analysts, producers, and other stakeholders to better assess current policies and programs influencing organic agriculture. Increased availability of information may help to improve the efficacy of legislation and provide opportunities for more research on organic agriculture. It is probable that individual state associations collect data about organic agriculture in their state but this is not readily available. MOFGA, for example, has data about the number of MOFGA members and the number of certified organic farms in Maine dating back to the 1970s. We recommend that MOFGA make this data available on their website.

Although the USDA has several useful databases, their information is not frequently updated. The most recent Census of Agriculture, for example, was in 2007. Additional data from private reports exists but is only accessible with a fee. The results of recent increases in funding for research through the 2008 Farm Bill will likely be seen in the near future, and will increase data collection. To increase data organization and availability we recommend that there be a webpage on the USDA website with links to each state and their individual data as far back as it exists.

Appendix A Contacts:

1. Jacomijn Gardei, MOFGA Certification Services, LLC.
2. CR Lawn, Founder, FedCo Seeds; MOFGA Board Member
3. Spencer Aitel, Owner, Two Loons Farm; MOFGA Board Member
4. Sam Hayward, Chef and Owner, Fore Street Restaurant; MOFGA Board Member
5. Tim Christensen, Senior Teaching Associate in Biology at Colby College; MOFGA Member
6. Emma Balazs, Intern, Snakeroot Farm
7. Rachael Katz, Owner, Smith Farm
8. Andy Smith, Co-Founder, Colby Organic Garden
9. Ben Hummel, Co-Founder, Colby Organic Garden
10. Joe Klaus, Director, Colby Dining Services
11. Jeff McCabe, House Representative (D-Skowhegan)
12. Bob Batteese, Division of Plant Industry, Maine Department of Agriculture
13. Rick Kersbergen, University of Maine Cooperative Extension
14. David Gulak, Market Manager, Barrels Community Market

Appendix B Sections of the 2008 Farm Bill that apply to organic agriculture

Horticulture and Organic Agriculture (Title X)	
National Organic Certification Cost-Share Program	Increases funding to subsidize $750 of organic costs for each eligible organic operation.
Organic Production and Marketing Data Collection	Allocates $5 million toward collecting organic production and marketing data to be spend over five years and an additional $5 million/year.
Support for the National Organic Program	$5 million authorized to be spent on the National Organic Program that establishes national organic standards. Funding increases to $11 million by 2012.
Conservation (Title II)	
Organic Transition Support	Includes organic production in eligibility for the Environmental Quality Incentives Program (EQIP) which provides payments up to $20,000 each year limited to $80,000 over six years.
Technical Assistance on Organic Conservation Practices	Provides technical assistance to organic producers to implement conservation practices outlined in the USDA conservation practices standards.
Organic Certification Cross-Link	Program established to allow producers participating in the Conservation Stewardship Program to undergo organic certification.
Organic Transition Incentives for Beginning Farmers	Under the Conservation Reserve Program (CRP) allows new farmers taking over CRP land to transition to organic starting one year before the termination of the CRP contract.
Credit (Title V)	
Organic Credit Provision	Adds those who plan to use loans for transitioning to organic production to the priority list of producers eligible for the Conservation Loan and Loan Guarantee Program.
Research (Title VII)	
Organic Agriculture Research and Extension Initiative	Increases funding to $78 million for 2009-2012 for the Organic Agriculture Research and Expansion Initiative and adds two new priorities for spending that focus on aspects of organic production.
Crop Insurance (Title XII)	
Organic Crop Insurance Provision	This title mandates that the Federal Crop Insurance Corporation (FCIC) study organic crop insurance and 'eliminate or reduce the premium surcharge for organic production.'
Trade (Title III)	
Market Access Program (MAP) Amendment on Organic Products	MAP (created in 1978) works to expand agricultural markets with cost-share funding; products produced organically are now included in this program.

Appendix C Which Maine colleges and universities purchase organic food?

Information provided by Joe Klaus, Director of Dining Services, Colby College. Alternative Food Program includes organic, local, or sustainable food programs.

College/University	Alternative Food Dining Program?
Public Colleges & Universities	
University of Southern Maine - Portland	Y
University of Maine - Orono	Y
University of Maine at Augusta	N
University of Maine at Farmington	N
University of Maine at Fort Kent	N
University of Maine at Machias	N
University of Maine at Presque Isle	N
Maine Maritime Academy	N
Maine Community College System	N
University of Maine Cooperative Extension	N
Maine Community College System	
Central Maine Community College	N
Eastern Maine Community College	N
Kennebec Valley Community College	N
Northern Maine Community College	N
Southern Maine Community College	N
Washington County Community College	N
York County Community College	N
State Training Academies	N
Private Colleges in Maine	
Andover College	N
Bates College	Y
Beal College	N
Bowdoin College	Y
Colby College	Y
College of the Atlantic	Y
Heartwood College of Art	N
Husson College	N
Maine College of Art	N
Maine Media College	N

Maine Theological Seminary	N
New England Bible College	N
New England School of Communications	N
Saint Joseph's College	N
Salt Institute for Documentary Studies	N
Southern New Hampshire University - Brunswick/Winter Harbor	N
Thomas College	N
Unity College	Y
University of New England	N

Works Cited

Ahn, S., W. B. Krohn, et al. (2002). Agricultural land changes in Maine a compilation and brief analysis of census of agriculture data, 1850--1997, University of Maine, Maine Agricultural and Forest Experiment Station.

American Farmland Trust (2002) Farming on the Edge: Sprawling Development Threatens America's Best Farmland. **Volume**, DOI:

Christensen, T. (2009). Senior Teaching Associate in Biology at Colby College and MOFGA member. Personal communication, Waterville.

Darling, B., E. Hansen, et al. (2007). The State of Land Use, Planning, and Development in Maine. Waterville, Colby College.

Dimitri, C. and L. Oberholtzer (2006) EU and U.S. Organic Markets Face Strong Demand Under Different Policies. Amber Waves Volume, DOI:

Get Free Maine. (2007, November 2009). "The Battle Over Genetic Engineering in Maine." from http://www.gefreemaine.org/staticpages/index.php?page=20040804021525935.

Get Real Get Maine. (2003). ""Get Real Maine" Campaign." Retrieved November 2009, 2009, from http://www.getrealmaine.com/learn/get_real_maine.html.

Greene, C., C. Dimitri, et al. (2009). Emerging Issues in the U.S. Organic Industry, USDA.

Greene, C., C. Dimitri, et al. (2005). Price Premiums Hold on as U.S. Organic Produce Market Expands, USDA*:* 22.

Hayward, S. (2009). Chef and Owner of Fore Street restaurant in Portland. Phone communication.

IFOAM. (2006). "Organic Agriculture and Human Health." Retrieved November 2009, 2009, from http://www.ifoam.org/growing_organic/1_arguments_for_oa/food_quality/pdfs/OA_HumanHealth_leaflet_screen.pdf.

IFOAM. (2009). "Definition of Organic Agriculture." Retrieved October 2009, 2009, from http://www.ifoam.org/growing_organic/definitions/doa/index.html.

IFOAMb. (2009). "Organic Agriculture's Role in Countering Climate Change." Retrieved November 2009, 2009, from http://www.ifoam.org/growing_organic/1_arguments_for_oa/environmental_benefits/climatechange.html.

Jacob, J. (1997). New Pioneers: The Back-the-Land Movement and the Search for a Sustainable Future. University Park, The Pennsylvania State University Press.

Krystallis, A. and G. Chryssohoidis (2005). "Consumers' willingness to pay for organic food - Factors that affect it and variation per organic product type." British Food Journal 107(4-5): 320-343.

Kuepper, G. and L. Gegner (2004). Organic Crop Production Overview: Fundamentals of Sustainable Agriculture, National Sustainable Agriculture Information Service (ATTRA).

Lawn, C. R. (2009). Founder of FedCo Seeds. Personal communication, Waterville.

Magkos, F., F. Arvaniti, et al. (2003). "Organic food: nutritious food or food for thought? A review of the evidence." International Journal of Food Sciences & Nutrition 54(5): 357.

Maine Farms for the Future. "Maine Farms for the Future." from http://www.mainefarmsforthefuture.com/.

Maine State Planning Office (2003). Blaine House Conference on Maine's Natural Resource-based Industry: Charting a New Course. Augusta, Maine State Planning Office.

Maine State Planning Office b. (2006). "Land for Maine's Future." Retrieved November 2009, from http://www.maine.gov/spo/lmf/.

MOFGA. (2009). "About MOFGA." from http://mofga.org/Home/AboutMOFGA/tabid/166/Default.aspx.

MOFGAb. (2009). "Abridged History." Retrieved October 2009, 2009, from http://mofga.org/Default.aspx?tabid=242.

MOFGAc. (2009). "A Timeline of MOFGA's History." Retrieved November 2009, 2009, from http://mofga.org/Default.aspx?tabid=512.

MOFGAd. (2009). "MOFGA Public Policy Initiatives." Retrieved October 2009, from http://www.mofga.org/Default.aspx?tabid=226.

MOFGAe (2009). Number of MOFGA Certified Organic Farms in Maine. Unity, MOFGA.

Palmer, K., G.T. Taylor, et al. (1992). Maine Politics and Government, University of Nebraska Press.

Presidents' Climate Commitment. (2007-2009). "About the American College & University Presidents' Climate Commitment." Retrieved November 2009, from http://www.presidentsclimatecommitment.org/about.

Schwartz, A., E. Sinnott, et al. (2007) The State of Land and Resource Use in the Unorganized Territories in Maine. Volume, DOI:

Sustainable Endowments Institute. (2009). "The College Sustainability Report Card." Retrieved November 2009, from http://www.greenreportcard.org/.

The Brookings Institution (2006). Charting Maine's Future: An Action Plan for Promoting Sustainable Prosperity and Quality Places, The Brookings Institution Metropolitan Policy Program.

USDA Agricultural Marketing Service. (2008, April 2008). "National Organic Program Background Information."

USDA Agricultural Marketing Service. (2009). "Farmers Markets and Local Food Marketing, Farmers Market Growth 1994-2009." Retrieved November 2009, from http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateS&navID=WholesaleandFarmersMarkets&leftNav=WholesaleandFarmersMarkets&page=WFMFarmersMarketGrowth&description=Farmers%20Market%20Growth&acct=frmrdirmkt.

USDA Agricultural Research Service (2007). "No Shortcuts in Checking Soil Health." Agricultural Research Magazine 55(6): 4-5.

USDA Economic Research Service. (2002, October 21 2009). "Final Organic Rule Governs Marketing and Production." Retrieved November 2009, from http://www.ers.usda.gov/features/organic/.

USDA Economic Research Service. (2009, September 1 2009). "Organic Agriculture: Organic Production and Costs." from http://www.ers.usda.gov/briefing/organic/Farmsector.htm.

USDA Economic Research Service b. (2009). "Organic Agriculture: 2008 Farm Act Provisions." Retrieved October 2009, 2009, from http://www.ers.usda.gov/Briefing/Organic/ProgramProvisions.htm.

USDA Economic Research Service c (2009). Farm Income: Data Files.

USDA Economic Research Service d (2009). Data Sets: Organic Production, USDA.

USDA National Agriculture Statistics Service Historical Census Publications.

USDA National Agriculture Statistics Service. (2007). "Census of Agriculture 2007." Retrieved October 2009, from http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp.

Vermont Organic Farmers, L. (2009). 2009 Statistics on Certified Organic Acreage in Vermont, Vermont Organic Farmers, LLC.

State of Sustainable Communities in Maine

By Steve Erario and Meghan Grogan

Executive Summary

The State of Sustainable Communities in Maine 2009 is the final chapter in *The State of Maine's Environment 2009*, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine. This is the fifth *State of Maine's Environment* report published since 2004.

Sustainable development requires reconciling competing environmental, economic, and social interests. Local governments are increasing efforts to address sustainability issues in response to perceived federal inaction. Maine currently lacks a method to effectively measure and encourage local sustainability activity. In response, we developed a prototype Sustainability Activity Index (SAI) to measure the seriousness with which Maine towns and cities are addressing energy and recycling issues. We evaluated energy and recycling scores for 476 Maine municipalities and found a low level of local activity, with a state-wide mean SAI score of 1.56 (SD ± 1.05) out of 8 possible points. We found that local governments with high SAI scores have larger budgets, are adjacent to postsecondary institutions, and have higher median household incomes and college graduation rates. We conclude that our SAI serves as a useful tool for comparing sustainability activity across Maine communities. We recommend the state delegate responsibility to a governmental or non-governmental entity that could publish SAI scores for all 489 incorporated municipalities in Maine. We recommend the responsible entity improve our SAI by engaging relevant stakeholders to create and publish an annual "Maine Local Government Sustainability Report Card" that is effective, robust, relevant, and transparent.

Introduction

Concept of Sustainability

Our Common Future, a report by the 1987 UN Commission on Environment and Development, defines sustainable development as "meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs" (UN WCED 1987). More commonly known as the Brundtland Report, this document commanded global attention and gave

political credibility to the concept of sustainability. The definition recognizes that successfully achieving sustainability requires reconciling the sometimes competing interests of social, environmental, and economic issues, illustrated by the three 'pillars' of sustainability (Figure 4.1).

Figure 4.1 The three pillars of sustainability

Importance of Local Government

The development of local sustainability initiatives in the U.S. has lagged behind other nations (Saha 2009). Though citizens are represented by their Congressional delegations, the problems of states and municipalities are often ignored or sacrificed to dominating issues and interests comprising the national political landscape, such as lobbies (Uphoff 1987). However, local action provides increased opportunities for citizen involvement in decision-making (John 1994).

Local governments can serve as laboratories of democracy, where experimentation in ordinances and initiatives carries less risk and fewer costs than large-scale federal action, encouraging creative policy-making and innovation. Municipal governments can also learn from the success stories of other local governments, and use that knowledge to save time and resources. Developing capacity for sustainability within local government is necessary for expanding sustainability capacity within civil society, and thus, action at the local level must increase if larger changes are to occur (Evans et al. 2005).

Local businesses, institutions (e.g. universities and churches), and community-based organizations represent stores of knowledge and

additional resources (Uphoff 1987). Local governments can benefit from relationships with these external agencies, and gain valuable local knowledge with more ease than state or federal governments. Local governments also have the most opportunity to influence school curriculums, conduct locally-marketed outreach, and encourage public participation. Additionally, local government officials can lead by example and adopt sustainability initiatives that inspire citizens and businesses to increase their own sustainable behavior (Roseland, Connelly et al. 2005).

Self-sustaining and well-organized local sustainability efforts are well-positioned to receive a growing supply of public and private funding aimed at increasing local sustainability. Successful public-private partnership projects include examples such as the private sector-financed light rail in Portland, Oregon (O'Meara 1999).

Home Energy Use: Illustrating Local Sustainability Impacts

The following example focuses on Maine home energy use to illustrate the importance of local action.

Maine residents face two compounding issues: low household incomes and costly energy bills. Compared to the Northeast, Maine's housing stock is the oldest and least energy efficient (Colby Environmental Policy Group 2008). Of all Northeastern states, Maine's housing stock is also subject to the highest "heating degree days," a measure of the heating intensity needed to warm a home. Eight in ten Maine homes are dependent on oil for water and space heating, a higher rate of dependence than other state in the U.S. (Colby Environmental Policy Group 2008).

Dependence on fossil fuels to heat homes contributes significantly to climate changing greenhouse gas emissions. Climate change may alter Maine's environment, increasing costs and decreasing revenues for municipalities. Rising sea levels and changing precipitation patterns may prove detrimental to Maine's built infrastructure, requiring local governments to pay for upgrades and repairs. Potentially lower winter snow accumulation could also lead to decreased winter sport tourism and associated municipal tax revenues (Frumhoff et al. 2007).

Energy inefficient homes and high dependence on heating oil negatively impact Maine's economic growth potential. For each $1.00 spent on heating oil in Maine, $0.85 leaves the state economy, representing a net export of $1.3 billion in 2008 (Baldacci and Kerry 2009). Exported dollars limit the potential to create quality Maine jobs and reduce positive economic multiplier effects of local purchases.

In the future, if Maine's dependence on fuel oil is not reduced, rising heating oil costs will increase the cost of living. This will further limit living affordability and increase social inequity in Maine (Kerry 2009). Figure 4.2 illustrates the estimated portion of the average Maine family budget needed to satisfy energy demands over time. Baldacci and Kerry (2009) find that expenses could rise from about 25% to about 50% of the Maine family budgets from 2008 to 2018. These changes may potentially lead to a sharp decline in municipal tax revenues from emigrating taxpayers unable to afford these cost of living increases. Changes to home energy expenditures may also increase municipal benefit expenditures to citizens that qualify for general assistance funds.

Figure 4.2 Portion of the Maine Family Budget spent on energy, health, and other expenses in 1998, 2008, and 2018. Energy costs are approximately 50% transportation, 40% home heating, and 10% electricity. Budget projections assume health care costs are capped at 30% of the family budget in 2018, (reproduced from Baldacci and Kerry 2009).

In sum, this example shows how local governments can be affected by sustainability inaction---economically, environmentally, and socially. Rising direct costs and falling tax commitments may create significant issues for municipalities failing to adequately plan for sustainability.

Local Government in Maine

Maine has a population of 1.3 million people who live in 917 units of local government. Approximately 10,000 people live in 428 of these units of government, categorized as the Unorganized Territory. Our study focuses on approximately 489 incorporated units of local government we commonly refer to as "local governments" or "municipalities" in this report. Table 4.1 shows the number and % of municipalities in each category by population size.

Table 4.1 Number of municipalities in five different population ranges; only 4% of municipalities have populations greater than 10,000 (Maine Municipal Association 2009).

Population Group	Number of Municipalities	% of Municipalities
10,000+	20	4%
5,000-9,999	45	9%
2,000-4,999	100	20%
1000-1,999	115	23%
Under 1,000	209	43%
Totals	**489**	**100%**

Focus of this Chapter

In this study we propose an initial framework assessment of Maine municipal sustainability activity focused on energy and recycling activity. What follows is a discussion of the methods we used to construct and analyze a Sustainability Activity Index (SAI); laws relevant to municipal energy and recycling activity; stakeholders in local sustainability outcomes; state of energy and recycling in Maine; analysis of findings; scenarios predicting changes in local SAI scores; conclusions; and recommendations for increasing local government sustainability activity.

Methods

Overview

We measured the activity of Maine municipalities around energy and recycling issues using a Sustainability Activity Index (SAI). The index is built from eight indicators weighted on a scale of zero to one for a maximum SAI score of eight. Some studies have examined ten or more sustainability indicators (e.g. Conroy 2009, Lubell 2009). We chose to focus on two areas: energy and recycling, because smaller cities appear to have less capacity to deal with sustainability issues (e.g. Lubell 2009). By selecting representable sustainability metrics we were better able to gather data and compare SAI scores across a greater number of municipalities.

We used ArcGIS 9.3 (ESRI 2009) to spatially represent relationships in our data. We assigned an index score to each municipality and joined it to data layers obtained from the online Maine GIS catalog, including median household income and the location of colleges and universities (MEGIS

2000a; MEGIS 2000b; MEGIS 2007). We obtained college degree attainment data from the U.S. Census, and municipal tax commitment data from the Maine revenue service (U.S. Census Bureau 2000; Maine Revenue Services 2007).

We used the statistics program PASW to analyze the statistical significance of factors on the SAI scores of municipalities. Using ordinary least squares (OLS) regression we estimated regression coefficients with confidence intervals in a model-fit covariance matrix using Durbin-Watson residuals.

Three Example Sustainability Activity Indices (SAIs)

We examined three studies that created indices to measure at least 16 sustainability policies and activity indicators across two dozen or more municipalities: Portney (2003), Conroy (2009), and Lubell (2009). Each study helped us to gain insight into the number of indicators used to measure municipal activity, the weight assigned to each indicator, the method used for data collection, and the number and size of municipalities measured.

Active U.S. Cities

Portney (2003) was the first to communicate the need for a city sustainability index to "capture in some appropriate way all the various dimensions of sustainability." He measured the "seriousness" with which 24 highly active cities addressed sustainability by measuring the presence of 50 sustainability initiatives in established plans or programs. Each indicator had a score of 0 or 1 based on whether or not the initiative was included in plans for a maximum score of 50. Cities in the study were limited to those who had implemented sustainability programs as a matter of public policy by January 1, 2000. For this reason, Portney was able to collect most of his data from these well-documented and available programs and plans (Portney 2003).

Indiana, Kentucky, and Ohio

Conroy (2009) studied the adoption of sustainability initiatives in Indiana, Kentucky, and Ohio. He constructed an SAI for communities with populations between 2,000 and 1 million residents to determine what sustainability-related activities were adopted. Conroy created a survey asking for organizational information and sustainability activity information on 16 different activities. The survey was sent to 975 community planning directors; 436 were returned. The SAI was based on the level of implementation of the 16 different activities. Each activity could receive a

score from 0 (no response/not performed) to 3 (activities in planning stage) for a maximum SAI score of 48 (Conroy and Iqbal 2009).

California's Central Valley

Lubell (2009) studied the adoption of sustainability scores in cities of California's Central Valley. Lubell created an index of sustainability activity for these communities with populations between 432 to 427,652 residents. Lubell identified 50 different sustainability policies with a weight of 0 (not present) or 1 (present) for a maximum score of 50. The research team collected data from 100 city general plans, municipal codes, official city websites, other web-based sources, and state-level databases for 11 policies. This was followed with email and telephone surveys of senior planning and development officials in each city (Lubell et al. 2009).

Maine's First SAI

Our proposed Maine SAI measures the general *activity* of a municipality around sustainability issues; in other words, it serves to gauge to what degree of seriousness municipalities are addressing sustainability. The SAI makes no claim of measuring the actual *sustainability* of a municipality. For example, the SAI measures whether or not a local government has signed a commitment to reduce its energy use, but does not measure the energy use per capita. This approach is useful because sustainability programs are relatively new and have yet to have had measurable 'sustainability' impacts on a community.

We measured sustainability activity (SAI score = 0.1) in 476 of 489 incorporated municipalities. In our statistical analysis we omitted municipalities with a SAI score = 0.1 in order to increase the accuracy of results.

In addition, we coded a 'zero' numerical value into a 'missing' value for the following factors: municipal tax commitment, household median income, and % population with a college education. We omitted the following number of local governments from independent analysis due to this method: 33 for municipal tax commitment, 6 for household median income, and 26 for % population with a college education.

SAI Indicators

We identified four variables in both the energy and recycling indices in order to measure potential differences in sustainability activity among different municipalities (Table 4.2).

Table 4.2 The eight indicators composing the Maine SAI.

	Indicator	Category
1	Energy Committee (Website)	Energy
2	Maine Partners for Cool Communities	Energy
3	Governor's Carbon Challenge	Energy
4	ICLEI-Local Governments for Sustainability	Energy
5	# Materials Recycled	Recycling
6	Recycling Ordinance	Recycling
7	Recycling Committee (SPO)	Recycling
8	Recycling Committee (Website)	Recycling

The Energy Activity Index

The energy index accounted for four of eight total possible SAI points (Table 4.2). One possible point for indicator (1) was awarded to municipalities with an energy committee listed on their official municipal website. Municipalities were awarded one possible point for participating in any of the climate change commitments, labeled indicators (2), (3), and (4) (Table 4.2). Although commitments are specifically targeted towards municipal climate change reductions, each focuses efforts towards reducing fossil fuel based energy use as a means for achieving these goals. Commitments indicate energy activity in local government because signatories have agreed to reduce greenhouse gas emissions or pay money to receive technical assistance in reducing climate-changing emissions from energy use. We obtained lists of program participants from the Maine Department of Environmental Protection (DEP), Maine Partners for Cool Communities (MPCC), and ICLEI---Local Governments for Sustainability (Table 4.3).

Table 4.3 Common climate change emission and energy use reduction commitments in Maine (ICLEI USA 2009; Maine Department of Environmental Protection 2009; Maine Partners for Cool Communities 2009).

Indicator Title	Maine Partners for Cool Communities (MPCC)	Maine Governor's Carbon Challenge (MGCC)	Cities for Climate Protection (CCP)
Website	coolmaine.org	maine.gov/dep/innovation/gcc	icleiusa.org
Closest Office	Portland, ME	Augusta, ME	Boston, MA

Organization(s) Responsible	American Lung Association of Maine; Maine Council of Churches; Physicians for Social Responsibility of Maine; Sierra Club - Maine Chapter	Maine Department of Environmental Protection: Office of Innovation	ICLEI - Local Governments for Sustainability
Greenhouse Gas Reduction (GHG) Target	7% reduction from 1990 levels by 2020	10% reduction from 1990 levels by 2020	None
Enforcement (Indicator of Commitment)	Provide information on activity; only 23 of 29 partners have signed GHG reduction target	Must submit bi-annual greenhouse gas inventory to indicate progress	$600 Annual Membership Fee
Benefit(s)	Recognition; technical support; information sharing and networking	Recognition; technical support; information sharing and networking	Technical support; information sharing and networking; GHG inventory software; research publications

The Recycling Activity Index

The recycling activity index accounted for four of eight total possible SAI points (Table 4.2). Indicators (5), (6), and (7) were scored using data collected from the Maine State Planning Office (SPO). One possible point for indicator (5) was awarded to municipalities that had 18 out of 18 total possible number of recycling options (e.g., cans, newspaper, and cardboard). Towns that recycled less than 18 types of materials were scored accordingly. For example, a town that recycled nine different materials received one half a point. One possible point for indicator (6) was offered to municipalities with a municipal recycling ordinance that sets some regulations around waste disposal and recycling. One point for indicator (7) was awarded to municipalities with a recycling committee listed by the SPO.

One possible point for indicator (8) was awarded to municipalities with a recycling committee listed on their official municipal website.

Potential Influences on SAI Scores

Conroy (2009) found a number of factors to significantly influence SAI scores, including community population size, planner's familiarity with the concept of sustainability, discussion of the concept by planning staff, and having activities with sustainability as a goal (Conroy and Iqbal 2009). Lubell (2009) found that sustainable policies are more likely to occur in cities that are larger, more populous, more financially independent, more socioeconomically advantaged, and that have higher stores of intellectual capital (Lubell et al. 2009).

Statistical and case studies specific to Maine municipal climate change and recycling activity found important influencing factors to include institutional capacity of municipalities and demographic factors such as population size, median household income, and percent of population with a bachelor's degree or higher (Miller 2009; Taatjes 2009).

Four Factors Potentially Influencing the Maine SAI

We examined four potential influences on SAI scores: municipal tax revenue (total dollars per municipality), % of population aged over 25 with a bachelor's degree or higher, median household income (dollars per household), and proximity to a college or university (number of colleges or universities within ten km).

Legislation

The growth of municipal level sustainability initiatives in recent years has its roots in modern environmental policy and is influenced by several federal laws.

Shifts in Federal Environmental Policy Approaches

The Brundtland Report evolved out of an existing awareness of the impacts of world economic activity on society and the environment. A large amount of natural resources were required to meet an exponential expansion in economic growth, especially after the industrialization era of World War II (Pinderhughes 2004). This economic expansion changed the political climate and raised awareness of environmental degradation, prompting the passing of substantial environmental regulations in the 1970s. During that decade, the U.S. Congress passed such influential legislation as the Clean Air Act,

Clean Water Act, Endangered Species Act, and the National Environmental Protection Act. Each of these laws targeted environmental concerns using a rigid, top-down approach (Fiorino 2006). However, by linking public health with conservation, these new regulations transformed each citizen into a stakeholder in the environment's well being (John 1994).

These federal regulations achieved some major successes. The Clean Air Act led to a 98% reduction in lead emissions between 1970 and 1995, as well as the improved air quality in most metropolitan areas (Mazmanian and Kraft 1999). Enforcement of the Clean Water Act has also resulted in improved water quality in many areas of the U.S. (John 1994).

The 1970s was followed by a more decentralized approach to federal policies with the Reagan administration. Called the "New Federalism", this era prompted Congress to attempt to shift power towards state and local governments. Consequently, Congress delegated responsibility to state and municipalities for implementing and enforcing most of the EPA's standards, but neglected to provide the funding necessary to meet compliance (Miller 2009).

A shift in responsibility of environmental regulation from the federal to state level continued in the 1990s. However, not all of these efforts were successful because some resulted in poor enforcement due to limited capacities of state governments.

The Bush administration was not a dedicated supporter of strong federal environmental policies. As a result, many states and cities adapted more stringent environmental regulations to address perceived federal inaction. California, for example, spurred on the movement of statewide greenhouse gas control and clean energy strategies by enacting a law in June 2002 that required reduced greenhouse gas emissions of all passenger vehicles sold in the state by 2009. Since the state's Air Resources Board implementing these regulations predated the U.S. EPA, it could set its own, more stringent air quality regulations. By fall 2007, seventeen other states had adopted the Californian standards (Miller 2009).

The Clinton administration's National Science and Technology Council's report entitled *Bridge to a Sustainable Future* acknowledges the importance of local governments in the transition towards sustainability by noting, "We must make choices today that increase the sustainability and desirability of our cities, towns, and rural areas if we are to preserve our natural environment and build a strong domestic economy" (Portney 2005). More recent legislation such as the American Recovery and Reinvestment Act of 2009 reflects a different environmental regulation approach, with the

allocation of $61.3 billion for energy related programs, such as state and local government investment in energy efficiency, weatherization of homes, and the purchasing of more energy efficient vehicles for state and local governments (H.R. 1 2009).

Examples of Local Solutions

On February, 16, 2006, the same day scheduled for the meeting for the Kyoto Protocol, Seattle Mayor Greg Nickels launched a campaign to encourage cities to achieve the goals of the Kyoto Protocol within their respective communities. Seven hundred and fifty mayors representing a quarter of the nation's population signed the agreement by the end of 2007. This accomplishment demonstrates the widespread interest among local communities to establish initiatives and programs that target sustainability and perform to specific needs.

For example, in Pittsburg, PA the Green Neighborhood Initiative, managed by a local non-profit, educates homeowners in low-to-moderate income neighborhoods in ways to reduce energy, water, and resource use to increase household income and spur neighborhood development (Mazmanian and Kraft 1999).

Further examples include Boulder, CO's pioneering "climate tax" on electricity use, as well as Los Angeles, CA's Million Trees LA initiative, which requires the city (in cooperation with community groups, businesses and individuals) to plant one million trees within the city bounds (Mazmanian and Kraft 1999).

Many cities have also employed land-use policies that reduce sprawl, preserve open space, and create walkable communities, promoting alternative transportation and the prioritization of energy efficiency in building codes (Newman and Kentworthy 1999).

Portland, ME has created the Eastern Waterfront Master Plan, targeting a mixed-use zoning approach that allows commercial fishing uses to merge with non-marine uses, such as retail, restaurant, and residential. This innovative approach creates jobs within walking distance of homes and services, helping to increase tax revenues used to protect and maintain the built infrastructure and environment of Portland's peninsula (Portland Maine's Planning & Urban Development Department). The City of Portland also upgraded their Metro bus system to run on clean burning natural gas in 2006. Using buses powered by natural gas contributes to improved air quality and reduces car dependence (Efficiency Maine).

Maine Laws

Energy

Energy efficiency and renewable energy are both important issues for Maine municipal governments, which spend approximately 5% of their budgets on energy expenditures. Maine state laws have targeted energy efficiency and renewable energy by creating renewable portfolio requirements, establishing the Maine Energy Conservation Board, and creating the Efficiency Maine Trust (Table 4.4).

Table 4.4 Relevant Maine laws encouraging energy efficiency and renewable energy

State Law	Year	Description	Location
Renewable Portfolio Standards	1999	Set a standard that 30% of energy generation sold in Maine be from renewable sources	(MRS Title 35-A. Chapter 32. §3210 1999)
Maine Energy Conservation Board	2007	Established the Maine Energy Conservation Board	(MRS Title 35-a. §10007 2007)
An Act Regarding Maine's Energy Future	2009	Created the Efficiency Maine Trust to coordinate residential, commercial, industrial, and municipal energy efficiency and renewable energy efforts	(LD 1485 2009)

Municipal energy conservation efforts have also received financial support from the 2009 American Recovery and Reinvestment Act in the form of Energy Efficiency and Conservation Block Grants. Maine municipalities were asked to submit applications for $5.75 million in funds to subsidize energy conservation planning and projects (Maine Public Utilities Commission 2009). This funding is an example of the increasing salience of energy and other sustainability issues now posed to receive federal financial support through local governments.

Recycling

Waste and recycling issues have historically been dealt with at the local level, although state laws offer some guidance on recycling issues (Table 4.5). The state prioritizes recycling after waste reduction and reuse, and has stated goals to increase recycling as a means to reduce municipal solid waste (MSW) generation. The state tracks progress by requiring municipalities to report MSW and recycling activity.

Table 4.5 Relevant Maine laws encouraging waste reduction and recycling

State Law	Year	Description	Location
Solid Waste Management Hierarchy	1989	Establishes solid waste hierarchy of reduction as guiding principle in statewide, regional, and local planning.	(MRS Title 38 Chapter 24 § 2133 1995)
Solid Waste Generation and Disposal Capacity Report	1995	Report required by Jan 1 2008 and annually thereafter	(MRS Title 38 Chapter 24 § 2124-A 1995)
State Goals	1995	Reduce MSW tonnage 5% biennially starting 2007	(MRS Title 38 Chapter 24 § 2132 1995)
Municipal Recycling	1995	Municipalities must make reasonable progress towards state goal; the state can offer funding to support these initiatives	(MRS Title 38 Chapter 24 § 2133 1995)

Stakeholders

Overview

The Maine SAI provides a framework through which municipalities can effectively approach sustainability issues---and one from which they can measure progress and adjust efforts accordingly. Stakeholders in the SAI and local government sustainability include a number of key constituents, including those who directly benefit from reduced sustainability costs and risks (i.e., communities and municipalities). Beneficiaries also include those with responsibility, authority, and/or stated interest in producing a more economically prosperous, environmentally resilient, and socially equitable

society (i.e., governments, government agencies, institutions, philanthropists, and nonprofits).

Community

Residents, business, and industry are the constituents most directly impacted by a municipality's activity (or lack thereof) to address sustainability issues. A progressive municipality may generate longer-term plans to incorporate diverse interests to mitigate potential risks from sustainability problems. A forward-looking local government may also help bring funding and direct assistance to communities from federal, state, and local government assistance programs to help reduce the costs of sustainability. In contrast, an inactive municipality can pass the costs and risks of poor planning and unreconciled conflicts over environmental, economic, and social concerns onto its constituents.

Local Governments

Municipal governments that score highly on the SAI are more likely to plan effectively to mitigate costs and risks from sustainability inaction. Governments that begin to develop in-house capacity to deal with sustainability issues and actively seek grant funding will be well positioned for an increasingly large flow of sustainability-assistance dollars from the state and federal level. Local government elected officials and staff that show they are proactively addressing sustainability issues will receive less future criticism and pressure for action from citizens. Active local governments that can most efficiently help mitigate sustainability costs through planning, financing mechanisms, and other strategic approaches can help achieve higher tax revenues through increased economic growth by creating favorable conditions for residences and businesses.

Organizations with Stated Sustainability Goals

Governments, institutions, philanthropists, and non-profits with stated goals that include principles of sustainability are interested in the SAI as a framework for issues and a mechanism for encouraging progress on these goals. A well-designed SAI may serve as a mechanism to consolidate efforts and resources from these stakeholders to focus on achieving a common set of sustainability goals.

State of Topic

Sustainability Activity Indices

An SAI can serve as a useful tool in assessing progress and determining effective ways to increase sustainability activity in municipalities. To our knowledge, there is no commonly agreed upon ranking of the sustainability of different towns and cities in any U.S. state. Some studies have created an SAI and applied it to U.S. communities, but never to Maine. The College Sustainability Report Card is one good example of a sustainability index that may help assess an organization's seriousness in addressing sustainability (Sustainable Endowments Institute 2009).

Research into Maine Municipal Energy and Recycling Responses

Various studies illustrate how Maine municipalities are addressing energy and recycling issues using case studies and limited statistics (Burt and Saxe 2008; Boyd 2009; Taatjes 2009). One study applied statistics to analyze the influence of various demographic and policy factors on recycling rates in Maine (Miller 2009). The University of New Hampshire currently has a research team focused on inventorying New England local municipal responses to energy and climate change issues (VanDeveer 2009).

Energy Use Trends

Maine has continuously, if sporadically, increased its overall energy use and peak energy demand. Energy prices have risen over the previous two decades (Colby Environmental Policy Group 2008). Maine consumed 458 trillion British thermal units (BTUs) of energy in 2006, approximately 0.5% of total U.S. energy demand (Baldacci and Kerry 2009).

Waste Generation and Recycling Trends

Maine citizens and businesses generated over 2 million tons of municipal solid waste (MSW) in 2007 (State Planning Office 2009). Therefore, Maine generates about 8.8 pounds of MSW per person per day, higher than the national average of 4.6 pounds of MSW per person per day. In 2007 Maine citizens and businesses recycled 35% of waste, or over 700,000 tons of recyclables. The Maine recycling rate is roughly equal with the national average of 33% (U.S. EPA 2008). State-wide recycling rates have remained stable for the previous decade after peaking at 42% in 1997 (Miller 2009).

Climate Change Commitment Trends

When Portland joined ICLEI in 2,000 they were the first Maine community to agree to a climate change commitment. No additional municipality indicated commitment in until 2004. Currently, 35 different municipalities have signed at least one commitment. In spite of recent increases in activity, less than one in ten local Maine governments have agreed to a climate change commitment.

Analysis

Measuring Maine Municipal Sustainability Activity

SAI Score Review

The mean SAI score was 1.56 (SD ± 1.05) out of 8 possible points. Only 4% or 21 of 476 measured Maine municipalities had an SAI score greater than or equal to 4 (Figure 4.3). According to our SAI measurements, Maine municipalities are not seriously addressing energy and recycling issues.

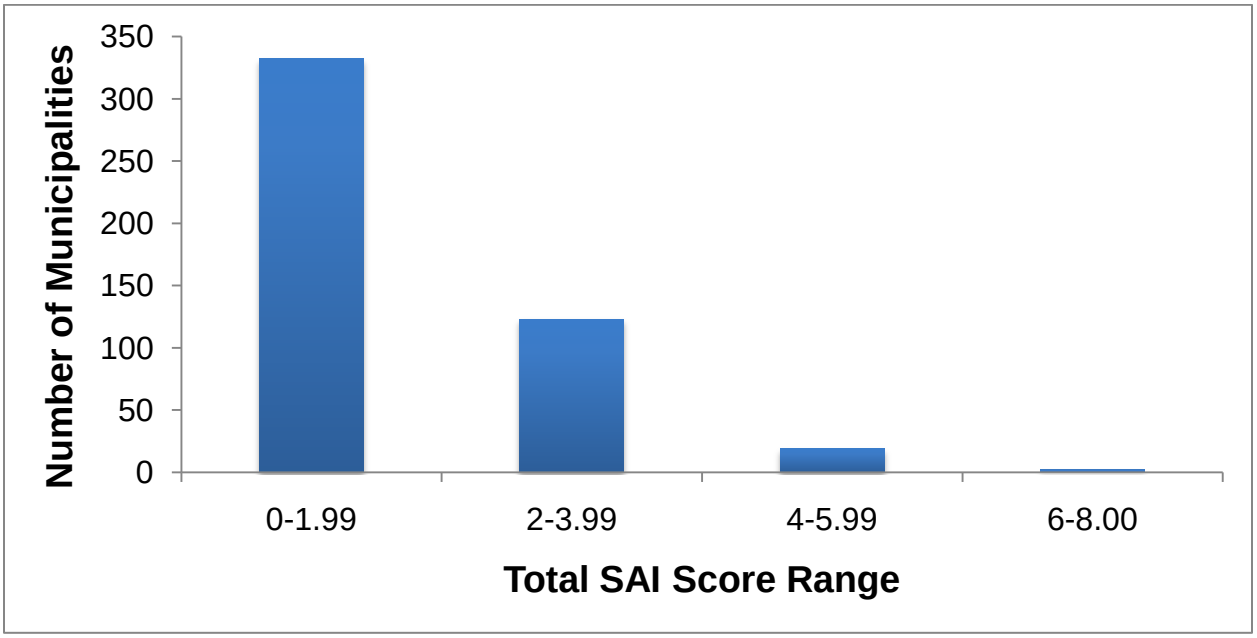


Figure 4.3 SAI score frequency for measured Maine municipalities

Energy SAI Score Review

The mean energy SAI score was 0.14 (SD ± 0.53) out of 4 possible points. Only 7%, or 35 of 476 measured municipalities scored at least one point on the energy SAI. Only one local government scored the maximum four points

on the energy SAI (Figure 4.4). This suggests that very few municipalities are active on energy issues according to the four energy indicators chosen for this study.

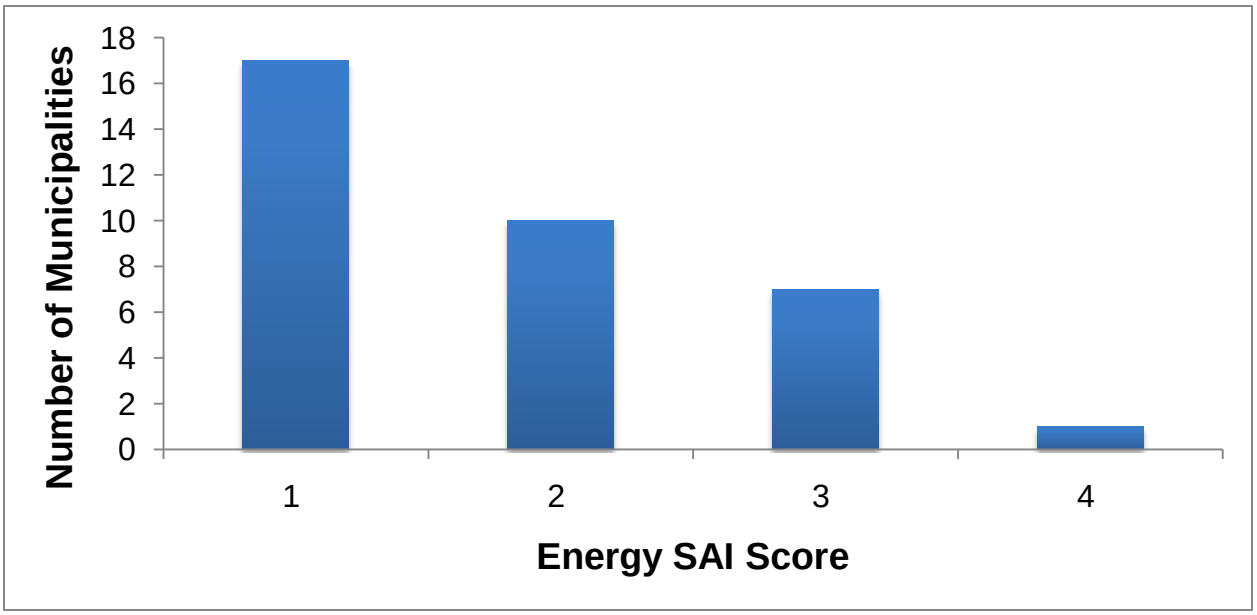


Figure 4.4 The energy SAI score for measured Maine municipalities

Two factors likely contribute to low energy SAI scores. First, scoring an energy SAI point requires more staff time, buy-in, and public commitment than does scoring a recycling SAI point. Second, energy efficiency and conservation is a recently emerging issue for local governments, meaning there has been more time for local governments to become active on recycling issues.

Seventeen municipalities had an energy committee listed on their official municipal website (Websites accessed October 2009). To score a point for indicator (1), a municipality must have created and actively maintained an official local government website. There were two main limitations to this indicator. First, the majority of local governments with a population less than 5,000 people did not have a website or did not appear to update it frequently. This may help account for energy SAI scores biased towards municipalities with larger budgets. Second, we observed municipalities with known active energy committees who did not list the committee on their website. These two factors illustrate how the energy SAI may measure a lower level of activity than is actually the case.

Twenty-nine municipalities were part of Maine Partners for Cool Communities; ten were part of the Governor's Carbon Challenge; and nine were part of ICLEI---Local Governments for Sustainability. To score a point

for indicators (2), (3), and (4), a municipality must have signed a climate change commitment from one of the three aforementioned organizations (Table 4.3). Scores were accurate for these indicators since membership information is frequently updated on each organizations' website.

Recycling SAI Score Review

The mean recycling SAI score was 1.72 (SD ± 0.89) out of 4 possible points. The mean recycling SAI score is 12 times higher than the mean energy score. The most frequent recycling SAI scores fell in the range between one to two points (Figure 4.5). This suggests that many municipalities are active on recycling issues according to the four recycling indicators chosen for this study.

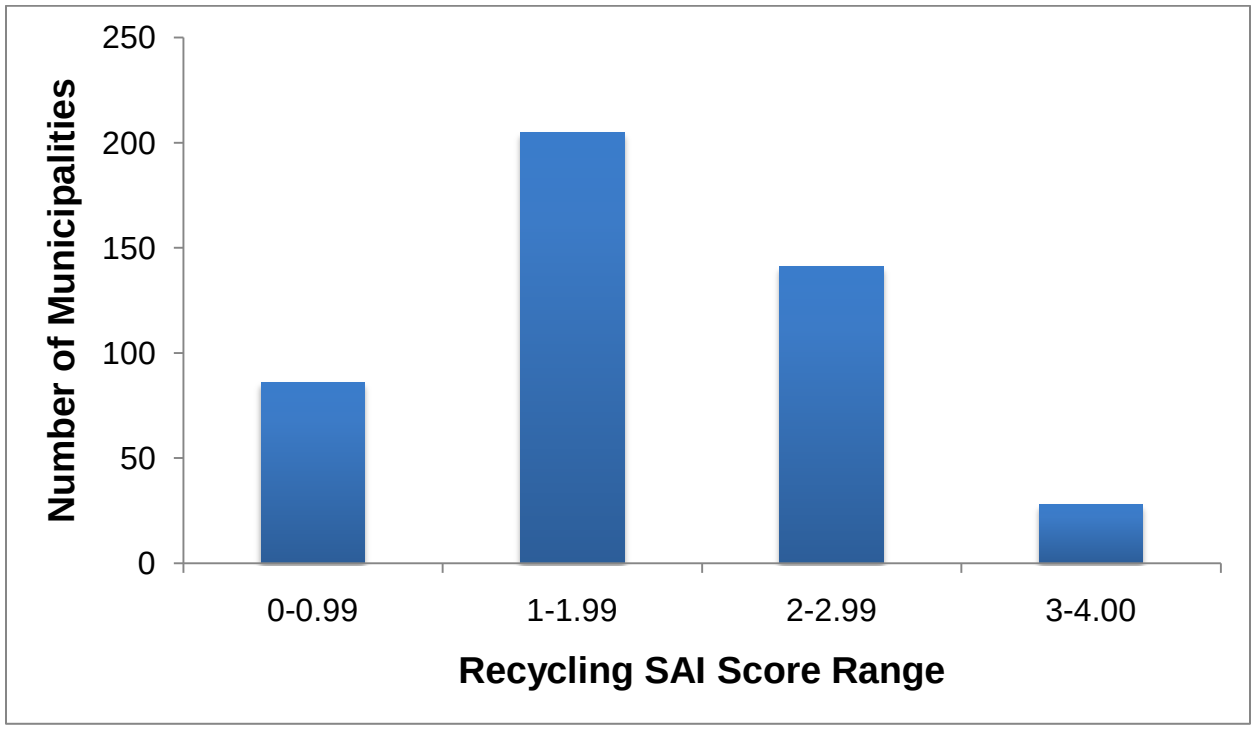


Figure 4.5 The recycling SAI score for measured Maine municipalities

Two factors likely contribute to high recycling SAI scores. First, scoring a recycling SAI point requires less serious commitment than scoring an energy SAI point. Second, recycling has long been recognized as an important issue in Maine. Municipalities have received substantial financial and technical support from federal and state grants since the solid waste management hierarchy was established two decades ago (Lee 2009).

Recycling SAI scores may also be higher than energy SAI scores because all Maine municipalities are required to report to the SPO on recycling activity, thus reducing gaps in the data.

Recycling SAI scores may represent higher than actual municipal recycling activity. The method we used to interpret Maine State Planning Office (SPO) data overemphasizes the level to which local governments are responsible for recycling. Our method assumes the policies of a regional program are representative of local activity. This skews results to favor municipalities that are part of collaborative joint recycling programs and reduces correlation between recycling SAI scores and local efforts.

We gathered SPO data for indicator (5) from a 2004 report on the number of types of recycling options available per municipality. The SPO expressed concerns with the accuracy and timeliness of data (Maine State Planning Office 2006). The majority of communities recycled more than nine of eighteen material types.

A total of 252 and 285 municipalities had a SPO listed recycling ordinance and recycling committee, respectively. A majority of these municipalities were listed as having an ordinance or committee by assuming that by participating in a regional program they had a local ordinance or committee. The SPO provided data for indicators (6) and (7) from a report on 2006 SPO listed recycling ordinances and recycling committees, respectively (Maine State Planning Office 2009; Maine State Planning Office 2009).

We found that 49 municipalities had a recycling committee listed on an official municipal website, five times less than the number listed by the SPO. Indicator (8) may have similar data quality issues to website-listed energy committees for indicator (1).

Geographic Distribution of SAI Scores

In spite of limitations to data quality and consistency, there are interesting patterns evident in SAI scores when spatially mapped using GIS (Figure 4.6). High SAI scores are concentrated in southern coastal municipalities. The SAI shows little sustainability activity in eastern or northern Maine.

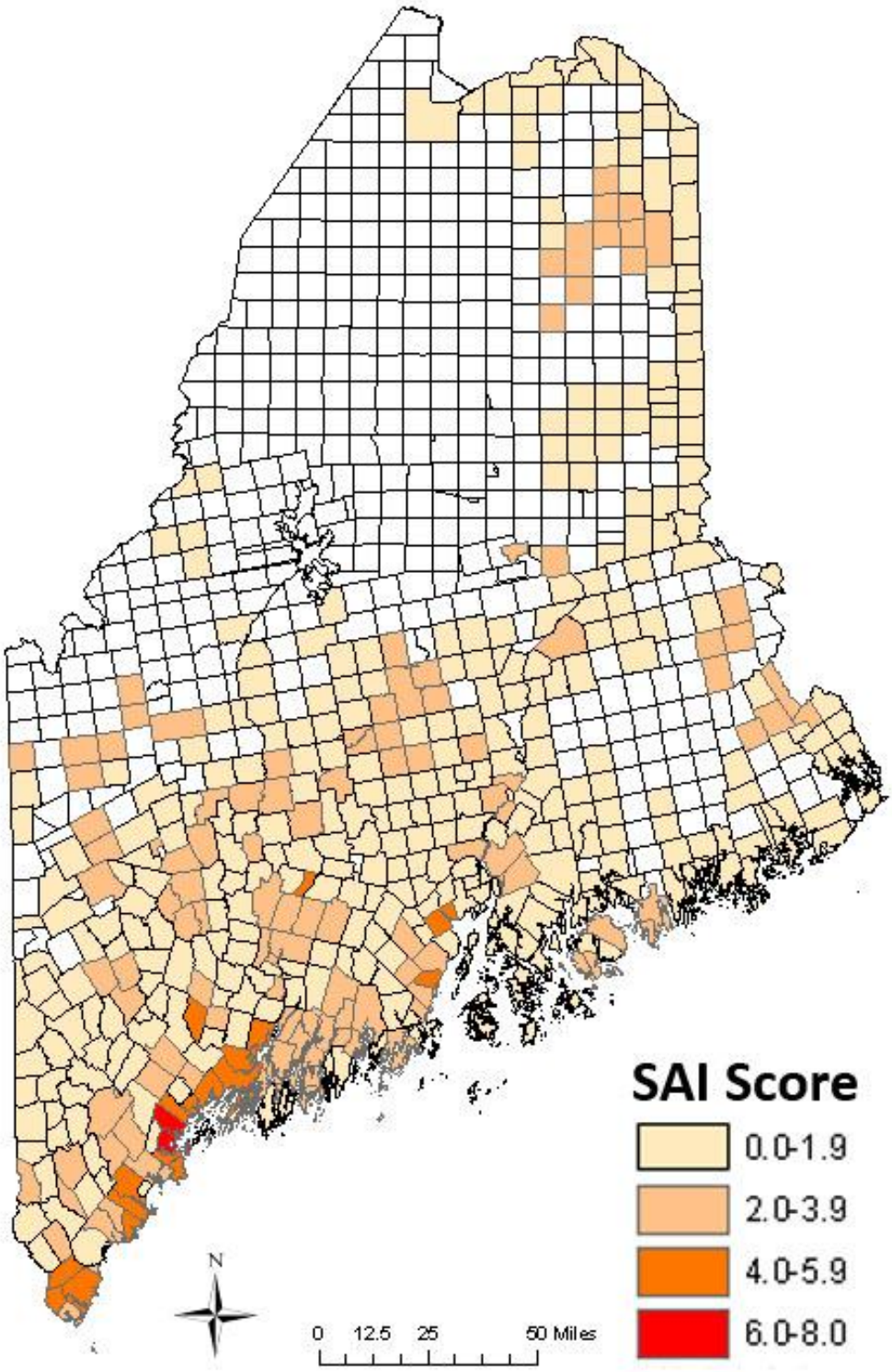


Figure 4.6 SAI scores by municipality show geographic concentration of the most active municipalities along the southern coast. The Unorganized Territory is not included in this study and therefore does not receive an SAI score.

Factors Influencing SAI Scores

We independently examined the influence of four different factors, or variables, on SAI scores (Table 4.6). We tested for and found normality in all four factors, setting the stage for further statistical analysis. The p value of each factor = 0.001, meaning the regression line equation was highly significant. The adjusted R^2 accounts for variation in index scores explained by the factors we independently examine. If a factor achieved the maximum R^2value, 1, then 100% of index score variation can be explained by the independently examined factor.

Table 4.6 Results of statistical analysis of influence of four factors on SAI scores

	Municipal Tax Revenue ($)	College Proximity (Number ≤ 10km)	% of Pop with B.A.	Median HH Income ($)
Significance	0.000	0.000	0.000	0.000
Adjusted R^2	0.321	0.058	0.126	0.108
Slope	6.81_{E}-8	0.185	0.039	4.04_{E}-5
Constant	1.328	1.455	0.871	0.167
Minimum	8,221	0	1.4	15,000
Maximum	125,703,082	7	58.7	85,889

Municipal Tax Revenue

Independent analysis showed that municipal revenue explained 32% of variance in SAI scores. This confirms other studies that indicate municipalities with higher budgets can hire additional staff to address sustainability issues (e.g., Allen 2009 and Conroy 2009). The relationship may help explain why the City of Portland, which has the highest budget of any Maine local government, scored highest on the SAI index.

The mean municipal budget for Maine municipalities is only $4.0 million (SD ± $8.8 million). Therefore, a large number of Maine municipalities with small budgets may require outside assistance to overcome a lack of local capacity to act on sustainability issues (e.g., Taatjes 2009).

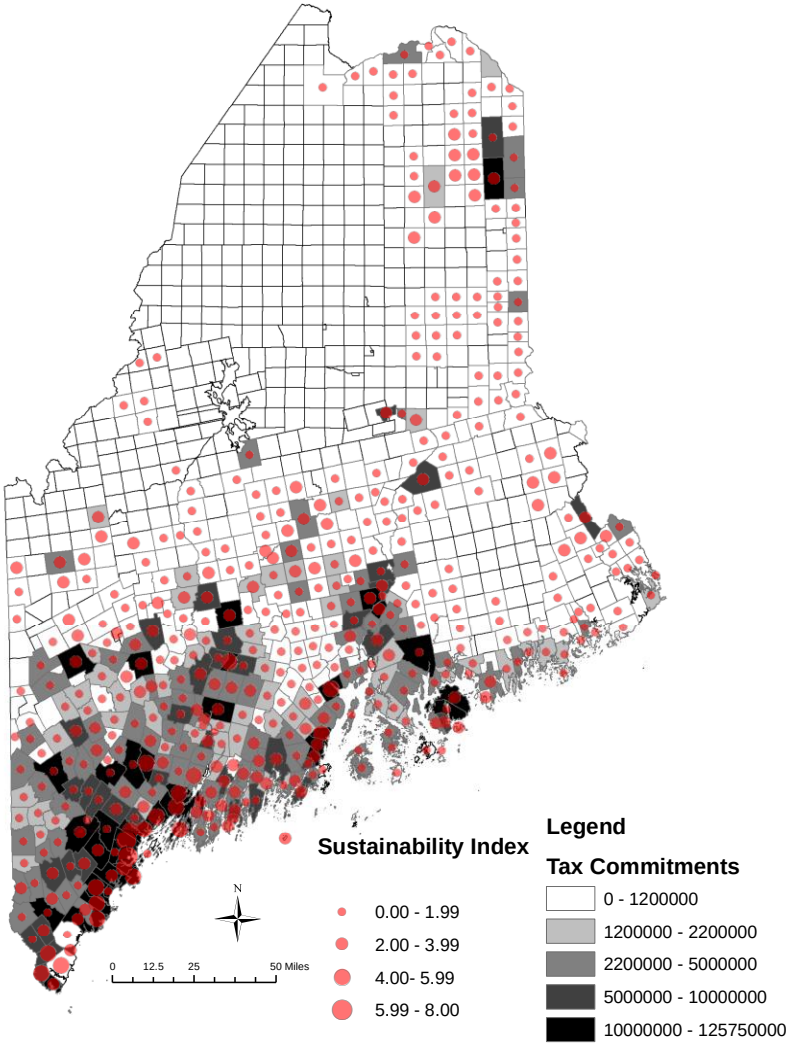


Figure 4.7 Spatial distribution showing a correlation between high SAI scores and high municipal tax commitments.

College Proximity

Independent analysis showed that the proximity of colleges and universities within a 10 km buffer explained 6% of variance in SAI scores. While there are no studies proving the statistical significance of this factor, anecdotal evidence suggests colleges may influence local sustainability. For example, the City of Waterville ranks 5th in the SAI routinely solicits sustainability consultation from three proximate colleges. Statewide training programs

such as the College Intern Sustainability Training Institute may increase the ability of post secondary institutions to enhance local government sustainability efforts.

Socioeconomic Factors

Independent analysis showed that the % of population over 25 with a bachelors degree explained 13% of variance in SAI scores. Independent analysis showed that median household incomes explained 11% of variance in SAI scores. This confirms other studies that indicate more educated communities may be more knowledgeable about the importance of sustainability issues, and that more affluent communities may be more willing to allocate resources to these issues (e.g., Miller 2009). These relationships may help explain why the 3rd most affluent and 6th most college educated community, the Town of Yarmouth, ranks 2nd in the SAI.

Strengthening the SAI Index

Strengthening the SAI will require overcoming current limitations in measurement and analysis.

Measurement is limited in a number of ways:

1) Narrow range of indicators. The SAI measured sustainability in only two areas: energy and recycling. Other index studies examine at least 16 other indicators in assessing local sustainability activity (Saha 2009). The SAI could also include indicators measuring activity on: building energy policy, community gardening, public transportation, sustainable procurement, and water quality.

2) Data gaps between local governments. We conducted surveys of municipal government websites to quantify energy and recycling committees and found that most local governments do not have an official website. This skews information about energy and recycling committees, especially for the smaller towns that do not have resources to create and update a website. We also used SPO data that was compiled on a regional scale for many local governments. Regional activity is not equivalent to activity of distinct units of local government, and therefore represents limited data availability across all local governments.

3) Lapsed relevancy of data. Information from the SPO was often not time-relevant, including data from 2004 quantifying the number of recycling material types per municipality. This information is out of date and no longer representative of the recycling programs of many Maine

municipalities. For example, thirty municipalities in the greater Portland area now offer single stream recycling through the Ecomaine single-stream recycling facility created in 2006 (EcoMaine 2009).

4) Limited comparability of indicators. Two indicators can demonstrate very different levels of activity from a municipality. For example, commitment to ICLEI – Local Governments for Sustainability requires annual membership fees and indicates serious commitment of local officials to address energy efficiency. Conversely, a recycling ordinance may not be enforced or may have been enacted in the distant past.

5) Lack of stakeholder engagement in defining indicators. Failure to engage a diverse range of stakeholders may lead to the establishment of arbitrary, ineffective indicators.

Analysis is also limited in a number of ways:

1) Limited statistical sophistication. We used simple linear regressions to independently analyze the influence of factors on SAI scores. Factors that may be indicators of the same effects, like population size and municipal budgets, may explain the same variance in SAI scores without more rigorous methods of testing.

2) Narrow range of factors. We statistically analyzed only four factors of at least ten factors studies proved to influence may influence SAI scores (e.g., Lowell 2009).

3) Low data transparency. Outside of the information in this report, our data will not be easily and anonymously accessible for public review.

Scenarios

Using information from the Maine SAI analysis, existing literature, and conversations with Maine sustainability experts, we constructed three scenarios that help illustrate potential changes to local government sustainability activity.

In general, scenarios may be explained by positive relationships between the following factors: fiscal health of government; effectiveness of institutional support; quality of funding assistance; prevalence of local leadership; salience of sustainability issues; amount of citizen activism; diffusion of successful sustainability models; and government official education about sustainability. For example, declining activity levels may be partially

explained by declining municipal budgets, declining salience of sustainability issues, or declining levels of local leadership, among other listed factors.

Dropping the Ball: Municipal Sustainability Activity Fades

In this scenario, local government activity decreases. For example, an economic recession or population decline causes a drop in municipal budgets, which forces local governments to focus solely on maintaining essential services such as education, infrastructure, and public safety.

Path of Least Resistance: Patchy Increases in Activity

In this scenario, the current trend of piecemeal improvements in local government activity continues. For example, federal leadership through energy efficiency grants spurs short term local government activity, but only incremental gains remain after the two year funding period lapses.

Leading the Charge: Municipal Activity Drives State Progress

In this scenario, local government activity expands, driving state responses to sustainability issues. For example, the creation of effective programs linking college capacity to address sustainability issues with the decision-making authority of municipal governments helps excite local government innovation.

Conclusions

We found that local government sustainability action is important for the continued economic, environmental, and social health of Maine communities, especially in light of state and federal inaction. We have four main conclusions:

First, studies have constructed Sustainability Activity Indices (SAIs) for various communities in the U.S., but, to our knowledge, never for Maine. The simple SAI developed in this study is a useful tool to measure and analyze Maine local government activity. For example, the SAI can target inactive local governments to effectively support increased local government sustainability activity. The index can also help to explain factors that may influence local activity levels. By beginning to study the effects of different factors that explain activity, the SAI can increase the effectiveness of policies designed to support local government sustainability.

Second, SAI scores indicate that local Maine governments have low levels of sustainability activity, with a mean SAI score of 1.56 (SD ± 1.05) out of 8

total possible points. Recycling SAI scores were higher than energy SAI scores, due in part to the relatively recent emphasis on addressing energy issues locally.

Third, the accuracy and usefulness of our prototype SAI was limited by our methods. These limitations include a narrow range of indicators, gaps in indicator data, and uncertainty whether our variables are accurate measures of sustainability.

Fourth, a well-designed SAI can help focus local activity by providing clarity around how to address complex and often overwhelming sustainability issues.

Recommendations

We recommend a number of actions to increase local Maine government sustainability. The State of Maine should:

1. Create a Sustainability Activity Index (SAI), published annually in the form of the "Maine Local Government Sustainability Report Card."

2. Clearly designate authority to a government agency or non-governmental organization to engage relevant stakeholders to outline procedures for Report Card data collection and analysis.

3. Focus the stakeholder group towards creating an effective, robust, relevant, and transparent Report Card. Data collection should gather quality, consistent, timely, and relevant data. Analysis should examine the influence of a wide array of factors on Report Card scores, as well as to include advanced statistical analysis methods including multivariate regression.

4. Use Report Card measurement and analysis to effectively increase local government sustainability activity. For example, create programs to link relevant college and university resources with local governments to create additional capacity to address municipal sustainability issues.

Works Cited

Baldacci, J. and J. Kerry (2009). State of Maine Comprehensive Energy Plan 2008-2009. Augusta, Governor's Office of Energy Independence and Security: 126.

Boyd, M. A. (2009). Maine Municipal Responses to Climate Change. J. LaPlante. Portland, The Muskie School, University of Southern Maine: 45.

Burt, A. and J. Saxe (2008). 2007 Maine Partners for Cool Communities Report: Solutions and services for solving global warming one Maine community at a time. Portland, Maine.

Colby Environmental Policy Group (2008). State of Maine's Environment 2008. Colby College Environmental Studies Program. Waterville, Maine.

Conroy, M. M. and A.-A. Iqbal (2009). "Adoption of sustainability initiatives in Indiana, Kentucky, and Ohio." Local Environment 14(2): 109-125.

EcoMaine. (2009). "EcoMaine Communities: Owner Members, Associate Members, and Recycling Members." 11 December, 2009, from http://www.ecomaine.org/communities/index.shtm.

Efficiency Maine. "Case Studies." Retrieved 14 December, 2009, from http://www.efficiencymaine.com/links_case_studies.htm.

Evans et al. (2005). Governing Sustainable Cities. London, Earthscan.

Fiorino, D. J. (2006). The New Environmental Regulation. Cambridge, The MIT Press.

Frumhoff, P. C. et al. (2007). Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Cambridge, MA, Union of Concerned Scientists (UCS).

H.R. 1 (2009). American Recovery and Reinvestment Act of 2009.

ICLEI USA. (2009). "ICLEI USA - Local Governments for Sustainability." Retrieved November 2009, from www.icleiusa.org.

John, D. (1994). Civic Environmentalism: Alternatives to Regulation in State and Communities. Washington D.C., Congressional Quarterly, Inc.

Kerry, J. (2009). Presentation: Maine State Energy Plan Presentation at Thomas College Ayotte Auditorium. S. Erario. Waterville, ME.

LD 1485 (2009). "An Act Regarding Maine's Energy Future."

Lee, F. (2009). Executive Director, Androscoggin Council of Governments. Phone interview by S. Erario.

Lubell, M. et al. (2009). "City Adoption of Environmentally Sustainable Policies in California's Central Valley." Journal of the American Planning Association 75(3): 293-308.

Maine Department of Environmental Protection. (2009). "Maine Department of Environmental Protection - Office of Innovation - Governor's Carbon Challenge Program." Retrieved November 2009, from http://maine.gov/dep/innovation/gcc.

Maine Municipal Association (2009). 2008 Fiscal Survey Report & Analysis. Augusta: 115.

Maine Partners for Cool Communities. (2009). "Maine Partners for Cool Communities Website." Retrieved November 2009, from www.coolmaine.org,.

Maine Public Utlitities Commission (2009). Request for Applications: Energy Efficiency and Conservation Block Grants to Unites of Local and County Government. Augusta, Maine, Efficiency Maine.

Maine Revenue Services. (2007). "MunVal07.xls." from http://www.maine.gov/spo/economics/economic/towndata.htm

Maine State Planning Office (2006). 2004 Municipal Recycling Programs in Maine.

Maine State Planning Office (2009). 2007 Recycling Committee Report (Rpt: ContactRecyCom).

Maine State Planning Office (2009). 2007 Town Ordinance Report (Rpt: Ordinance).

Mazmanian, D. A. and M. E. Kraft, Eds. (1999). Toward Sustainable Communities: Transition and Transformations in Environmental Policy. American and Comparitive Environmental Policy. Cambridge.

MEGIS (2000a). GEOMCDCCD, Maine Office of GIS.

MEGIS (2000b). DP3, Maine Office of GIS.

MEGIS (2007). COLLEGES, Maine Office of GIS.

Miller, N. (2009). Environmental Politics: Stakeholders, Interests, and Policymaking. New York, Routledge.

Miller, N. (2009). Recycling in Maine Municipalities: What Makes it Tick? Augusta, Maine State Planning Office.

MRS Title 35-a. §10007 (2007). "Maine Energy Conservation Board."

MRS Title 35-A. Chapter 32. §3210 (1999). Renewable Portfolio Standards.

MRS Title 38 Chapter 24 § 2124-A (1995). Solid Waste Generation and Disposal Capacity Report.

MRS Title 38 Chapter 24 § 2132 (1995). Waste reduction and recycling: State goals.

MRS Title 38 Chapter 24 § 2133 (1995). Municipal Recycling.

Newman, P. and J. Kentworthy (1999). Sustainability and Cities: Overcoming Automobile Dependence. Washington, D.C., Island Press.

O'Meara, M. (1999). Reinventing Cities for People and the Plant. Worldwatch Paper. Washington, D.C. 147.

Pinderhughes, R. (2004). Alternative Urban Futures: Planning for Sustainable Development in Cities Throughout the World. New York, Rowman & Littlefield Publishers, Inc.

Portland Maine's Planning & Urban Development Department. "Eastern Waterfont Master Plan." Retrieved 14 December, 2009, from http://www.ci.portland.me.us/planning/easternwater.asp.

Portney, K. (2005). "Civic Engagement and Sustainable Cities in the United States." Public Administration Review 65(5): 579-591.

Portney, K. E. (2003). Taking Cities Seriously: Economic Development, the Environment, and Quality of Life in American Cities. Cambridge, The MIT Press.

Roseland, M., S. Connelly, et al. (2005). Toward Sustainable Communities: Resources for Citizens and their Governments. Canada, New Society Publishers.

Saha, D. (2009). "Empirical research on local government sustainability efforts in the USA: gaps in the current literature." Local Environment 14(1): 17-30.

State Planning Office, E. O. (2009). Solid Waste Generation & Disposal Capacity Report for Calendar Year 2007. Augusta, Maine State Planning Office: 43.

Sustainable Endowments Institute (2009). "The College Sustainability Report Card."

Taatjes, J. (2009). Local Climate Action: The Story of Eight Towns in Maine. Brunswick, Bowdoin College: 44.

U.S. Census Bureau (2000). DP-2. Profile of Selected Social Characteristics, U.S. Census Bureau.

U.S. EPA (2008). Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007. Washington, DC, Environmental Protection Agency.

UN WCED. (1987). "Our Common Future." Retrieved 3 December 2009, from http://www.un-documents.net/wced-ocf.htm.

Uphoff, N. (1987). Local Institutions and Participation for Sustainable Development, International Institute for Environment and Development

Sweedish International Development Agency: 16.

VanDeveer, S. D. (2009). Department of Political Science, University of New Hampshire. Personal communication by S. Erario.